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Effect of Growth Regulators on Morphological Parameters, Phenology, Yield Attributes and Yield of Muskmelon under Graded Levels of Moisture Stress

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A B S T R A C T

A study on the effect of growth regulators on morphological parameters, phenology and yield of muskmelon under graded levels of moisture stress condition was carried out at College of Horticulture, Anantharajupeta. The experiment was laid out in two factorial completely randomized block design replicated thrice. Factor 1 comprised of three moisture stress levels imposed at 50 % flowering stage, T_1- 0 days water stress, T_2 - 7 days water stress and T_3 - 14 days water stress and Factor 2comprised of three foliar sprays, S_1- water spray (Control), S_2 – Gibberellic acid (50 ppm), S_3 – Salicylic acid (0.5 mM). The results indicated that among the moisture stress levels, the morphological parameters and yield attributes were superior in plants not subjected to water stress. Among the foliar sprays tried, SA (0.5 mM) and GA_3 (50 ppm) improved the morphological and yield attributes compared to water spray. Under stress condition, the exogenous application of gibberellic acid @ 50 ppm and salicylic acid @ 0.5 mM was effective in mitigating the deleterious effect of drought stress in muskmelon.

Introduction

Muskmelon (*Cucumis melo* L., 2n= 24) is one of the most economically important vining fruit vegetables especially during summer in hot and dry regions of India. Muskmelon known as dessert vegetable is a native of tropical Africa. In India, muskmelon occupies an area of 52 thousand hectares with an annual production of about 1135 thousand metric tonnes (Anon, 2017- 2018). Muskmelon is a wholesome food and it helps in managing hypertension, improves vision, acts as an immunity booster, prevents heart disease, controls diabetes and lowers cholesterol.

In agriculture, abiotic and biotic stress factors are a product of global climate change; intensive agricultural practices cause substantial yield loss and are becoming more widespread besides, the increase in demand for farmable land (Stefanelli *et al.*, 2010). Among the abiotic factors, drought is predominant as it affects plant growth and development (Ferrara *et al.*, 2011) and limits agricultural crop production (Rebey *et al*., 2012). Drought, slows growth, induces stomatal closure and thereby reduces photosynthesis (Nemeth *et al.,* 2002). Plant hormones are vital components of plant growth and development, which help in plant adaptation through their responses on stomatal functioning, plant water balance, nutrient allocations, and source-sink transitions, besides maintaining antioxidant status especially during stress. For mitigation of drought, foliar sprays with chemicals or plant growth regulators which render drought proofing to the crop will serve as cost effective strategies. The main objective of this study was to test the exogenous application of SA and GA_3 on muskmelon under different water stress conditions at 50 % flowering stage on morphological and yield attributes of muskmelon.

Materials and Methods

Field experiment was carried out at College of Horticulture, Anantharajupeta, Dr. Y.S.R. Horticultural University, Andhra Pradesh, during late *kharif*, 2018.The experiment was laid out in a naturally ventilated polyhouse, in two factorial CRD with three replications. Factor 1: comprised of three moisture stress levels imposed at 50 % flowering stage *viz*., T_1- 0 days water stress, T_2 - 7 days water stress and T_3 - 14 days water stress and Factor 2: comprised of three foliar sprays, S_1- water spray (Control), S_2 - Gibberellic acid (50 ppm), S_3 - Salicylic acid (0.5 mM). A local genotype, Alpur Green was selected for this experiment and sown at 100×75cm.

Results and Discussion

Morphology of muskmelon as influenced by moisture stress and PGR's

Statistically non-significant variation on vine length, internodal length and number of nodes of muskmelon was recorded at 30 DAS Where as significant variation was recorded in vine length, internodal length and number of nodes due to different moisture stress levels, plant growth regulators and their interactions at 60 DAS and at harvest.

The vine length, internodal length and number of nodes of muskmelon both at 60 DAS (183.66 cm, 13.66 cm and 22.93) and at harvest (273.84 cm, 15.82 cm and 38.72) were superior in the non stressed plants compared to the treatments where water stress was imposed for seven and 14 days during flowering stage (Table 1).

Among the sprays tried for mitigation of water stress both at 60 DAS (180.56 cm, 13.10 cm and 23.50) and at harvest (260.65 cm, 14.92 cm and 39.36), GA_3 50 ppm spray recorded maximum vine length followed by SA 0.5 mM. Among the interactions, treatment combinations T_1S_2 (0days water stress + $GA_3$50ppm) was found superior in the vinelength

With the increase in deficit irrigation, vine length was reduced. This reduction could be attributed to a lower rate of cell division in the plant. Exogenously applied GA_3 increased the cell division and cell elongation by enhancing endogenous gibberellic acid content under drought stress in turn increasing the plant height, internodal length and number of nodes (Rodriguez *et al.,* 2006 and Shao *et al.,* 2008). Singh and Usha (2003) suggested that the promotive effect of SA on growth of plants under drought stress may be related to the induction of antioxidant responses which protect plant from damage.

These results are in agreement with those reported by Sinojiya *et al*., (2015) in watermelon, Mirabad *et al.,* (2014), Chourasiya *et al.,* (2016) in muskmelon and Ajay *et al.,* (2018) in cucumber.

Table.1 Effect of moisture stress levels and plant growth regulators on morphological parameters of muskmelon

		Vine length (cm)			Internodal length (cm)			Number of nodes		
		At 30 DAS	At 60 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest
Stress levels (T)	0 days water stress (T_1)	83.88	183.66	273.84	6.56	13.67	15.82	9.92	22.93	38.72
	7 days water stress (T_2)	91.11	163.93	252.10	7.11	11.33	12.99	9.58	20.87	37.17
	14 days water stress (T_3)	88.33	140.54	230.33	6.56	9.67	11.17	8.93	19.03	34.99
	CD (5%)	N.S	1.00	1.07	N.S	0.24	0.44	N.S	0.13	0.11
Sprays (S)	Water spray (S_1)	92.22	147.10	243.70	7.33	10.03	11.70	9.43	18.50	34.42
	GA_3 50 ppm (S_2)	86.66	180.56	260.65	6.44	13.10	14.92	9.30	23.50	39.36
	SA 0.5 mM (S_3)	84.44	160.47	251.92	6.44	11.53	13.36	9.70	20.83	37.10
	CD (5%)	N.S	1.00	1.07	N.S	0.24	0.44	N.S	0.13	0.11

N.S-Non-significant

Table.2 Interaction effect of moisture stress levels and plant growth regulators on morphological parameters of muskmelon

	Sprays (S)	Vine length (cm)			Internodal length (cm)			Number of nodes		
		At 30 DAS	At 60 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest
0 days water stress (T_1)	Water spray (S_1)	93.33	170.30	265.30	7.33	12.00	13.87	10.33	20.60	36.60
	GA_3 50 ppm (S_2)	83.33	200.50	281.16	6.33	15.00	17.33	9.33	25.60	41.17
	SA 0.5 mM (S_3)	75.00	180.20	275.06	6.00	14.00	16.27	10.10	22.60	38.40
7 days water stress (T_2)	Water spray (S_1)	91.66	150.80	245.20	7.00	10.00	11.70	8.93	18.60	34.40
	GA_3 50 ppm (S_2)	93.33	180.40	260.70	7.67	13.00	14.80	9.23	23.50	39.50
	SA 0.5 mM (S_3)	88.33	160.60	250.40	6.67	11.00	12.47	10.57	20.50	37.60
14 days water stress (T_3)	Water spray (S_1)	91.66	120.20	220.60	7.66	8.10	9.53	9.03	16.30	32.27
	GA_3 50 ppm (S_2)	83.33	160.80	240.10	5.33	11.30	12.63	9.33	21.40	37.40
	SA 0.5 mM (S_3)	90.00	140.63	230.30	6.67	9.60	11.33	8.43	19.40	35.30
	C.D (5%)	N.S	1.74	1.85	N.S	0.41	0.76	N.S	0.22	0.20

N.S-Non-significant

Table.3 Effect of moisture stress levels and plant growth regulators on phenology of muskmelon

		Node at which the first staminate flower appeared	Node at which the first pistillate flower appeared	Female to male flower ratio	Days to 50 % flowering	Node number of first fruit set	Days to appearance of first staminate flower	Days to appearance of first pistillate flower
Stress levels (T)	0 days water stress (T_1)	3.58	5.17	0.13	35.48	6.43	27.58	35.56
	7 days water stress (T_2)	3.36	5.22	0.08	37.79	6.92	27.57	36.32
	14 days water stress (T_3)	3.66	5.38	0.07	36.90	6.48	26.17	35.88
	CD (5%)	N.S	N.S	0.010	N.S	N.S	N.S	N.S
Sprays (S)	Water spray (S_1)	3.67	5.58	0.08	36.97	7.01	27.40	36.33
	GA_3 50 ppm (S_2)	3.42	4.96	0.11	33.77	6.44	27.63	35.54
	SA 0.5 mM (S_3)	3.50	5.23	0.10	35.70	6.38	27.70	35.88
	CD (5%)	N.S	N.S	0.010	N.S	N.S	N.S	N.S

N.S-Non-significant

Table.4 Interaction effect of moisture stress levels and plant growth regulators on phenology of muskmelon

Stress levels (T)	Sprays (S)	Node at which the first staminate Flower appeared	Node at which the first pistillate flower appeared	Female to male flower ratio	Days to 50 % flowering	Node number of first fruit set	Days to appearance of first staminate flower	Days to appearance of first pistillate flower
	CD (5%)	N.S	N.S	0.017	N.S	N.S	N.S	N.S
0 days water stress (T_1)								
7 days water stress (T_2)								
14 days water stress (T_3)								
	Water spray (S_1)	4.50	5.83	0.10	36.97	7.00	27.40	35.97
	GA_3 50 ppm (S_2)	3.20	4.83	0.15	33.77	6.50	27.63	34.80
	SA 0.5 mM (S_3)	3.03	4.83	0.14	35.70	5.80	27.70	35.90
	Water spray (S_1)	3.20	5.40	0.07	38.23	7.63	27.60	36.40
	GA_3 50 ppm (S_2)	3.40	4.87	0.09	37.40	6.17	28.37	36.87
	SA 0.5 mM (S_3)	3.47	5.40	0.08	37.73	6.97	26.73	35.70
	Water spray (S_1)	3.30	5.50	0.06	38.27	6.40	26.70	36.63
	GA_3 50 ppm (S_2)	3.67	5.17	0.08	36.17	6.67	25.73	34.97
	SA 0.5 mM (S_3)	4.00	5.47	0.07	36.27	6.37	26.07	36.03

N.S-Non-significant

Table.5 Effect of moisture stress levels and plant growth regulators on yield attributes and yield of muskmelon

		Days to first fruit harvest	Number of fruits per plant	Fruit weight (kg)	Yield per plant (kg)	Yield per hectare (t/ha)
Stress levels (T)	0 days water stress (T_1)	72.16	3.97	1.14	4.51	56.36
	7 days water stress (T_2)	67.13	3.67	0.92	3.38	42.22
	14 days water stress (T_3)	61.30	1.84	0.67	1.23	15.42
	CD (5%)	1.07	0.06	0.01	0.01	0.19
Sprays (S)	Water spray	68.50	2.97	0.85	2.68	33.51
	GA_3 50 ppm	64.89	3.17	0.91	3.03	37.92
	SA 0.5 mM	67.20	3.33	0.97	3.41	42.57
	CD (5%)	1.07	0.06	0.01	0.01	0.19

Table.6 Interaction effect of moisture stress levels and plant growth regulators on yield attributes and yields of muskmelon

Water stress (T)	Sprays (S)	Days to first fruit harvest	Number of fruits per plant	Fruit weight (kg)	Yield per plant (kg)	Yield per hectare (t/ha)
0 days water stress (T_1)	Water spray (S_1)	73.30	3.83	1.06	4.06	50.75
	GA_3 50 ppm (S_2)	70.87	3.92	1.13	4.42	55.25
	SA 0.5 mM (S_3)	72.30	4.15	1.12	5.05	63.09
7 days water stress (T_2)	Water spray (S_1)	68.50	3.42	0.85	2.90	36.29
	GA_3 50 ppm (S_2)	65.30	3.77	0.92	3.46	43.25
	SA 0.5 mM (S_3)	67.60	3.81	0.99	3.77	47.13
14 days water stress (T_3)	Water spray (S_1)	63.70	1.66	0.65	1.08	13.50
	GA_3 50 ppm (S_2)	58.50	1.83	0.67	1.22	15.25
	SA 0.5 mM (S_3)	61.70	2.02	0.69	1.40	17.50
	CD (5%)	N.S	0.10	0.02	0.03	0.33

N.S-Non-significant

Phenology of muskmelon as affected by moisture stress and PGR's

Days to appearance of first staminate and pistillate flower, node at which the first staminate and pistillate flower appeared, days to 50 % flowering recorded non-significant variation due to moisture stress levels, growth regulators and their interaction, as stress was not imposed during early stages of growth. The influence of different levels of moisture stress and growth regulators on node number of first fruit set was non-significant. Female to male flower ratio (0.13) was superior in the non stressed plants compared to the treatments where water stress was imposed for seven and 14 days during flowering stage (Table 3). Female to male sex ratio was high when gibberellic acid 50 ppm was sprayed which was on par with SA 0.5mM. T_1S_2 recorded the highest sex ratio (0.15) which was on par with T_1S_3 (0.14). In the water stressed treatments (Table 4), the treatment combination T_2S_2 recorded the high sex ratio which was on par with T_2S_3.

Spraying of growth regulators *i.e*., GA_3 at lower concentrations increased the female to male sex ratio. These results were in close agreement with those of Ghani *et al.,* (2013) in cucumber, Patil *et al.,* (2014) in muskmelon, Devi and Madhanakumari (2015) and Chourasiya *et al.,* (2016) in muskmelon and Ajay *et al.,* (2018) in cucumber.

Effect of moisture stress levels and plant growth regulators on yield of muskmelon

The muskmelon plants which were not subjected to water stress surpassed the water stressed plants in both growth and yield, recorded superior values for parameters *viz*., number of fruits per plant (3.97), fruit weight (1.14 kg), yield per plant (4.51 kg) and per hectare (56.36 t/ha). However, minimum number of days to first fruit harvest (61.30 days) was significantly superior in plants subjected to 14 days water stress (Table 5).

Spraying of salicylic acid 0.5 mM recorded significantly higher number of fruits per plant (3.33), fruit weight (0.97 kg), yield per plant (3.41 kg), yield per hectare (42.57 t/ha) in muskmelon both in non-stressed and water stressed plants followed by GA_3 50 ppm. Number of days taken for first fruit harvest was minimum with GA_3 50 ppm treatment followed by SA 0.5 mM (Table 5).

Among the interactions, the treatment combinations in nonstressed plants sprayed with salicylic acid 0.5 mM (T_1S_3) was significantly high in number of fruits per plant (4.15), fruit weight (1.22 kg), yield per plant (5.05 kg) and yield per hectare (63.09 t/ha). In water stressed plants, T_2S_3 was found to be superior in the aforesaid parameters. However number of fruits per plant was high in T_2S_3 which was on par with T_2S_2. Minimum number of days to first fruit harvest, fruit length and fruit diameter among the treatment combinations was non-significant (Table 6).

Adequate irrigation in muskmelon seems to have boosted the vigorous growth eventually increasing the number of fruits per plant, whereas the plants subjected to water stress showed a decline in the number of fruits. Exogenous SA application increases fruit weight and fruits per plant. The results corroborated with the findings of Rashidi and Seyfi (2007), Keshavarzpour and Rashidi (2011) and Mirabad *et al*., (2014) in muskmelon.

Increase of yield under foliar application of salicylic acid could be ascribed to the well-known roles of salicylic acid in improving photosynthetic parameters, translocation of sugars from source to sink and in boosting the plant water relations aiding in osmotic adjustment under stress. The trend of present results was in line with the findings of Nasrabi *et al*., (2015) and Mirabad *et al.*, (2014) in muskmelon.

In conclusion the yield of muskmelon gradually declined with the increase in water stress. The reduction in yield as a result of water stress could be curbed by the exogenous supply of growth regulators. Among the foliar sprays tried, gibberellic acid 50 ppm and salicylic acid 0.5 mM improved the growth and yield of muskmelon both under stressed as well as in non- stressed conditions (control). Exogenous application of gibberellic acid 50 ppm or salicylic acid 0.5 mM can effectively mitigate the deleterious effect of drought stress in muskmelon.

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