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Influence of Brassinosteroid (BR) and Kinetin on Drymatter Accumulation and Partitioning in Relation to Yield of Chickpea (*Cicer arietinum* L.) under Water Stress

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ABSTRACT

Two field experiments were conducted at Agricultural College Farm, Bapatla during two consecutive *rabi* seasons of 2008-09 and 2009-10 to study the influence of brassinosteroid and kinetin on dry matter accumulation and partitioning in relation to yield of chickpea under water stress. The experiment was laid out in split plot design with nine treatments and replicated four times. The results revealed that the influence of BR and Kinetin as foliar spray on dry matter partitioning was more pronounced under water stress condition compared to control. The reduction in dry matter allocation into vegetative parts was more under BR spray followed by Kinetin; indicating under stress conditions dry matter partitioning was more to reproductive parts. In case of seed yield, no water stress recorded significantly higher seed yield (31.9%) over water stress from vegetative stage. Among foliar sprays, homobrassinolide spray @ 1ppm resulted in higher seed yield (20.9%) than no spray and it was on par with kinetin spray @ 5ppm. Seed yield had significant positive correlation with root, stem, leaf and pod weight. It can be concluded that homobrassinolide spray @1ppm at initial stages of pod development would provide better dry matter partitioning resulting potential seed yield under water stress conditions in chickpea at coastal regions of Andhra Pradesh.

Key words : Brassinosteroid (BR), Chickpea, Kinetin, Total Drymatter partitioning, Water stress, Yield.

Chickpea (*Cicer arietinum* L) is the fourth largest grain legume crop in the world, with a total production of 10.9 million tons from an area of 12.0 million ha and a productivity of 0.91 t/ha (FAO 2010). In India the area under chickpea is 8.2 million hectare with productivity 895 kg/ha and production 7.3 million tons. It constitutes about 35% of the total pulse acreage and 50 % of the total production in the country (Venkatesh and Basu, 2011). Over 80 per cent of the global chickpea is grown as rainfed in post-rainy season encountering drought situation. Though alleviation of adverse effects of water stress on growth and yield of plants through the use of plant growth substances has been reported earlier, information on the use of Kinetin and Brassinosteroids in chickpea is meager.

Brassinosteroids (BRs) are a group of naturally occurring plant steroidal compounds, considering as sixth group of phytohormones with significant growth promoting activity as they influence varied developmental processes like growth, germination of seeds, rhizogenesis, flowering and senescence.

Chickpea is reported to mature early under water stress, but the influence of water stress at vegetative and flowering stage and on dry matter partitioning has not been reported in a quantitative manner. Since so many beneficial effects have been attributed to kinetin and brassinosteroids, their impact on chickpea growth and yield under water stress is focused in this study. As water stress is the major limiting factor for agricultural production; drymatter accumulation and its partitioning with seed yield remain as the major selection criteria for improved adaptation to such adverse environment.

Keeping in view of the above facts, the present investigation was undertaken to study the influence of brassinosteroid and kinetin on dry matter accumulation and partitioning in relation to yield of chickpea under water stress.

MATERIAL AND METHODS

Field experiments were conducted at Agricultural College, Bapatla during the two consecutive seasons of rabi 2008-09 (season I) and rabi 2009-2010 (season II) in split plot design with nine treatments replicated four times. The treatments consists of three water stress levels *viz.*, M_0 (No stress), M_1 (water stress from vegetative stage) and M_2 (water stress from flowering stage) as main plots. Each main plot consists of three subplots i.e., foliar sprays at 40 DAS *viz.*, S_0 (No spray), S_1 (Kinetin spray @ 5ppm) and S_2 (Brassinosteroid (BR) spray @ 1ppm).

The experimental soil was black clay loam in texture, slightly alkaline in reaction, low in organic carbon, low in available nitrogen, medium in available phosphorus and high in available potassium. Bold and healthy seeds were selected for sowing. Recommended dose of fertilizers (20:50:0::N:P_2O_5:K_2O kg/ha) was applied at the time of sowing and the seed were inoculated with Rhizobium culture, i.e., *Mesorhizobium ciceri.* One day after sowing, herbicide Pendimethalin was sprayed @ 10 ml L^{-1} to arrest the weed growth. At 20 and 55 DAS, imposition of main treatment (stress levels), and at 40 DAS imposition of sub treatments (foliar sprays of BR and Kinetin) were undertaken. The total dry matter accumulation and its partitioning was estimated at 15 days intervals right from the sowing to harvest from the five adjacent plants sampled from each treatment in four replications and then separated into roots, stems, leaves and pods. The plant parts were dried to a constant weight in hot-air oven at 80°C for two days and the dry weights were recorded and expressed in g plant^{-1}. The yield data was recorded at the time of harvest and made to kg/ha.

RESULTS AND DISCUSSION

Foliar application of Brassinosteroid (BR) and Kinetin brought significant improvements in dry matter production, its partitioning, seed yield and harvest index under water stress. The unstressed plants with BR spray produced the highest dry matter (14.31 g/pl) that was 22.9% more than the control; however it was at par with kinetin spray (Table 1). The changes in dry matter accumulation and its distribution in root, leaves, stem and pods showed independent behavior. Foliar spray of homobrassinolide might have improved rooting, enhanced uptake of more nutrients and initiation of various physiological and biochemical processes, ultimately leading to increased total dry matter production. It resulted in partitioning of drymatter 8.6% into root, 8.4% into stem, 12.7% into leaf and 70.3% into pod. In unstressed plants kinetin spray (M_0S_1) increased the leaf dry weight. The dry matter allocation was 65.2% in pod, 12.5% in leaf, 9.7% in stem and 12.6% in root. Though root dry weight was more initially in the plants stressed from vegetative stage with kinetin spray (M_1S_1); but after 75 DAS the plants subjected to vegetative stress with homobrassinolide spray (M_1S_2) attained maximum root dry weight. Homobrassinolide applied plants accumulated the highest total dry matter in all the three water stress treatments indicating its positive impact in accumulating and partitioning the dry matter. Similar result had been reported by Bajguz and Hayat (2009).

Improved harvest index under water stress condition represents increased physiological capacity to mobilize photoassimilates and their proper translocations from source to sink. Harvest index was lower under water stress conditions as compared to irrigated condition. It shows poor translocation of assimilates towards economic parts under water stress conditions. Application of homobrassinolide @ 1 ppm increased the translocation towards economic parts consequently enhanced the harvest index. It was reported earlier that decrease in harvest index (HI) in chickpea under stress was due to suppression of flowering and pod number per plant (Pandey et al., 2003).

Seed yield had significant positive correlation with root weight, stem weight, leaf weight, pod weight and ultimately to harvest index (Table 2). Root weight and leaf weight per plant are negatively correlated (-0.14).

Control plants recorded higher seed yield (2321.64 kg/ha) and was at par with the plants stressed from flowering stage (Table 3). It might be due to the increased competition for assimilates between roots and developing reproductive structures at flowering stage. Plants stressed from vegetative stage recorded the minimum seed yield (1678.05 kg/ha) due to severe detrimental effect of water stress. The seed yield in control was

Table 1. Dry matter accumulation & partitioning and at harvest in component parts of chickpea influenced by kinetin and homobrassinolide sprays under water stress.

	Treatments	Dry matter partitioning (g/plant) in Season I						Dry matter partitioning (g/plant) in Season II					
		Root	Stem	Leaf	Pod	TOTAL	HI	Root	Stem	Leaf	Pod	TOTAL	HI
Main	M_0	1.13	1.16	1.82	9.12	13.23	47.5	1.22	1.17	1.83	9.72	13.94	52.96
	M_1	1.14	0.91	1.22	6.34	9.61	45.3	1.25	0.95	1.23	6.66	10.09	44.40
	M_2	1.12	1.04	1.74	7.64	11.54	45.5	1.23	1.05	1.76	8.05	12.09	45.13
	SEm +	0.03	0.05	0.06	0.61	0.92	0.51	0.03	0.05	0.06	0.42	0.93	0.14
	CD (0.05)	0.10	0.16	0.20	2.17	3.24	1.79	0.09	0.16	0.19	1.49	3.29	0.49
Sub	S_0	1.10	1.00	1.55	7.10	10.75	45.3	1.19	1.04	1.54	7.55	11.32	46.76
	S_1	1.13	1.04	1.63	7.76	11.56	46.1	1.22	1.06	1.64	8.20	12.12	47.45
	S_2	1.16	1.07	1.61	8.24	12.08	46.9	1.28	1.08	1.63	8.67	12.66	48.27
	SEm +	0.03	0.03	0.05	0.30	0.47	0.23	0.03	0.03	0.05	0.30	0.48	0.21
	CD (0.05)	NS	NS	NS	0.89	NS	0.70	NS	NS	NS	0.90	NS	0.61
Interactions	M_0S_0	1.09	1.14	1.78	8.21	12.23	46.0	1.15	1.16	1.75	8.99	13.05	52.80
	M_0S_1	1.13	1.16	1.88	9.34	13.51	47.2	1.22	1.17	1.89	9.86	14.14	52.86
	M_0S_2	1.19	1.18	1.81	9.82	14.00	49.4	1.30	1.19	1.84	10.31	14.64	53.21
	M_1S_0	1.12	0.87	1.16	5.84	8.00	44.5	1.22	0.93	1.16	6.21	9.52	42.39
	M_1S_1	1.14	0.91	1.23	6.21	9.40	45.5	1.22	0.96	1.24	6.79	10.21	43.98
	M_1S_2	1.17	0.95	1.27	6.97	10.36	45.8	1.30	0.97	1.28	6.98	10.53	46.82
	M_2S_0	1.10	0.99	1.70	7.25	11.04	45.3	1.22	1.02	1.71	7.45	11.40	45.09
	M_2S_1	1.11	1.05	1.78	7.73	11.67	45.5	1.21	1.05	1.79	7.96	12.01	45.51
	M_2S_2	1.15	1.08	1.75	7.93	11.91	45.6	1.25	1.09	1.77	8.72	12.83	44.78
	SEm +	0.05	0.07	0.09	0.74	1.14	0.61	0.05	0.06	0.09	0.60	1.15	0.32
	CD (0.05)	0.10	0.14	0.20	1.51	2.45	1.31	0.10	0.14	0.19	1.28	2.52	0.67
	CV(%)	12.31	10.92	11.32	13.47	12.38	15.27	11.99	10.72	11.00	12.94	12.48	12.31

M_0 : No stress
M_1 : Water Stress from vegetative stage
M_2 : Water Stress from flowering stage

S_0 : No spray
S_1 : Spray with Kinetin @ 5.0 ppm
S_2 : Spray with Homobrassinolide @ 1.0 ppm

Table 2. Correlation among dry matter accumulation, seed yield and harvest index in chickpea as influenced by kinetin and homobrassinolide sprays under water stress .

Parameters	Root Wt	Stem wt.	Leaf wt	Pod wt.	TDMA	Seed	Harvest
Root Wt	1.00						
Stem wt.	0.11	1.00					
Leaf wt	-0.14	0.91	1.00				
Pod wt.	0.29	0.97	0.86	1.00			
TDMA	0.22	0.98	0.90	1.00	1.00		
Seed yield	0.31	0.96	0.85	1.00	0.99	1.00	
HarvestInvest	0.60	0.75	0.53	0.87	0.83	0.89	1.00

Table 3. Effect of Water stress and foliar spray of kinetin and homobrassinolide on Seed yield (kg/ha) of Chickpea (pooled data of 2008-09 and 2009-10)

Treatment	Seed yield (kg/ha)
Main Treatments	
M_0 (No stress)	2321.6
M_1 (Water Stress from vegetative stage)	1678.1
M_2 (Water Stress from flowering stage)	2148.5
SEm$\pm$	70.3
CD (0.05)	247.6
Sub Treatments	
S_0 No spray	1836.5
S_1 (spray with Kinetin @ 5 ppm)	2049.0
S_2 (spray with Homobrassinolide @ 1 ppm)	2262.6
SEm$\pm$	69.4
CD (0.05)	206.1
Interactions	
M_0S_0	2100.5
M_0S_1	2335.6
M_0S_2	2528.9
M_1S_0	1471.0
M_1S_1	1677.2
M_1S_2	1886.0
M_2S_0	1938.2
M_2S_1	2134.3
M_2S_2	2373.0
SEm$\pm$	120.7
CD (0.05)	254.2
CV (%)	12.9

31.9% high over water stress from vegetative stage. Among sprays, homobrassinolide @ 1 ppm resulted in higher seed yield (20.9%) than no spray and it was on par with kinetin spray @ 5 ppm. Similar effect was observed by Bajguz and Hayat (2009). Water stress from vegetative stage with no spray recorded the minimum seed yield indicating its adverse effect of water stress. More limited availability of photoassimilates could be one reason for fewer pods on water stressed plants as reported by Yadava and Singh (2008) and Singh *et al.* (2008).

Conclusion

The ultimate seed yield depends primarily on the per cent dry matter partitioned to seed rather than that of total dry matter produced. Water stress induced from vegetative stage till harvest was deleterious than that of water stress during flowering to harvest. Among foliar sprays, spray with homobrassinolide @1ppm at initial stage of pod development *i.e*; at 40 DAS resulted in higher seed yield (20.9%) over no spray and it was on par with kinetin spray. The present investigation supported the use of plant growth regulators like homobrassinolide and kinetin for alleviating the adverse effects of water stress in chickpea.

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