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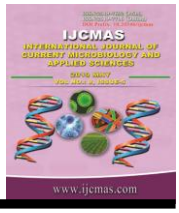

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Effect of Foliar Application of Organic and Inorganic Substances on the Yield of Chick Pea under Limited Water Supply

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A B S T R A C T

A field experiment was conducted on clayey soil during *Rabi* season of 2011-12 to 2013-2014 to study effects of foliar application of organic and inorganic substances on the yield of chick pea (GJG-3) under limited water supply at Main Dry Farming Research Station, Junagadh Agricultural University, Targhadia. The experiment comprising of 2 main plot (2 levels of irrigation) and seven sub plot treatments (spraying of organic and inorganic substances) laid out in split plot design with three replications. Effect of foliar application of organic and inorganic substances treatments on root length, plant height, number of branches/plant, and mature pods/plant at 75 DAS and maturity were significantly improved under two irrigation (one irrigation at flowering and second at pod development stage (I_2). The stem growth rate, leaf growth rate, pod growth rate and crop growth rate were significantly affected due to combined effect of irrigation and foliar sprays but root growth rate and partitioning percentage were non-significant. The significantly higher yields (pod, seed, straw, biological), shelling %, 100 pod weight, and 100 seed weight of gram were obtained due to foliar spraying of T_1 (KNO_3 @ 2%), T_2 (Urea @ 2%) and T_5 (Cow urine 100 ml/l) as compared to control. While, yields (pod, seed, straw and biological), harvest index, shelling %, 100 pod weight, 100 seed weight of gram were not significantly affected due to combined effect of irrigation and foliar spray during all the years of experimentation as well as in pooled results. While seed index was significantly affected due to foliar spray in the year 2012. On the basis of pooled result the data indicated that two irrigation (one irrigation at flowering and second at pod development stage I_2) gave the highest gross income (Rs.57904/ha) and net return (Rs.39213/ha). Foliar application with KNO_3 @ 2% at flowering and pod development stages found better in respect of gross income (Rs.59285/ha), net return (Rs.39634/ha) and B:C ratio 3.02.

Introduction

Chickpea is an important pulse crop of Gujarat grown in winter. Chickpea is cultivated in 1.50 lakhs hectare having productivity of 885 kg/ha. Chickpea is mostly grown on reserve soil moisture particularly in Bhal and Ghed region and in area where water supply is limited as per rainfall condition. Thus, moisture stress usually

occurs at various growth stages particularly during pod development. It was reported that in pulses, moisture stress has drastic effects on nitrogen fixation besides plant growth. The number of rhizobia in soil also declines drastically as soil dries. Foliar nutrition may appear to mitigate this effect and increase drought tolerance. There were also evidenced that plant growth regulators could be used to partially counteract environmental stresses and improve crop productivity. Hence, the experiment was planned to study the effects of foliar application of organic and inorganic substances on the yield of chick pea (GJG-3) under limited water supply.

Materials and Methods

The experiment was carried out on Chick pea during *kharif* seasons of 2011-12 to 2013-2014 at Dry Farming Research Station, Junagadh Agricultural University, Targhadia (Dist: Rajkot, Gujarat, India). The physical characteristics of soil measured were viz. field capacity (34.25) wilting point (17.26), apparent specific gravity (1.38%), infiltration rate (10.15 mm/hr), maximum WHC (58.55) and soil texture clayey. The chemical characteristics of soil at 0-15 cm depth had pH 7.85, electrical conductivity (EC) 0.47m.mhos, organic carbon (OC) 4.95%, available P_2O_5 26.53 kg/ha and available K_2O 448 kg/ha and available S 17.14 mg/kg. The experiment included total 14 treatment combinations viz. Main factor involves 2 levels of irrigation I_1. One irrigation (at flowering stage), I_2. Two irrigation (One irrigation at flowering and second at pod development stage) and Sub factor involve 7 foliar spray treatments at flowering and pod development stages i.e. T_1 – KNO_3 2 %, T_2 – Urea 2 %, T_3 – Varmiwash 100 ml/l, T_4 – Jivamrut 100 ml/l (Water-200 lit., Cow Dung-10 kg., Cow Urine 10 lit., Deshi Jaggary - 2kg., Flour of Pulses-2 kg, handful soil from rhizosphere of banyan tree), T_5 – Cow urine 100 ml/l, T_6 – Water Spray and T_7 – Control each replicates thrice in Split Plot Design with the plot size of 4.5 m X 2.4 m. The spacing and seed rate were 60 cm x 10 cm and 75 kg/ha, respectively. The fertilizer was given as 20:40:0.0 NPK kg/ha.

Results and Discussion

Growth parameters

Effect of irrigation

The pooled result of three years (Table 1) reveled that root length, plant height, number of branches per plant and mature pods per plant at 75 DAS and maturity stages were significantly improved due to two irrigation (one irrigation at flowering and second at pod development stage (I_2) as compared one irrigation I_1. Higher values of root length (12.23 cm at 75 DAS and 15.36 cm at maturity), plant height (47.7 cm at 75 DAS and 50.1 cm at maturity), number of branches per plant (6.20 at 75 DAS and 6.77 at maturity), number of mature pods per plant (9.28 at 75 DAS and 51.07 at maturity) of gram were obtained with two irrigations (one irrigation at flowering and second at pod development stage I_2). These findings were similar to Bardhan *et al.,* (2007) and Patel *et al.,* (2012).

Effect of foliar spraying

Pooled results (Table 1) also indicated that root length, plant height, number of branches/plant and mature pods/plant at 75 DAS and maturity were significantly affected due to foliar spraying of organic and inorganic substances. Higher values of root length (13.27 cm at 75 DAS and 16.57 cm at maturity), plant height (48.6 cm at 75 DAS and 50.7 cm at maturity), number of branches per plant (6.39 at 75 DAS and 7.08 at maturity), number of mature pods per plant

(9.74 at 75 DAS and 50.42 at maturity) of gram were recorded due to spraying of KNO_3 @ 2 % (T_1) at flowering and pod development stages. The findings were close with findings of Kumar *et al.,* (2011), Singh *et al.,* (2012), Goud *et al.,* (2014), Elamin and Madhvi (2015), Hiwale (2015) and Verma *et al.,* (2017).

1(c) Interaction effect of I x T

The root length, plant height, number of branches/plant and mature pods/plant at 75 DAS and maturity were not significantly affected due to combined effect of irrigation and foliar sprays in pooled results.

Physiological growth parameters

Effect of irrigation

The data of pooled result (Table 2) reveled that root growth rate, stem growth rate, leaf growth rate, pod growth rate, crop growth rate and partitioning percentage were significantly higher due to two irrigation (one irrigation at flowering and second at pod development stage (I_2) as compared I_1. Higher values of root rate(0.118 $gm^{-2}day^{-1}$) stem growth rate (1.45 $gm^{-2}day^{-1}$), leaf growth rate(2.29 $gm^{-2}day^{-1}$), pod growth rate(6.03 $gm^{-2}day^{-1}$), crop growth rate (11.34 $gm^{-2}day^{-1}$) and partitioning percentage (52.81%) of gram were obtained with two irrigations (one irrigation at flowering and second at pod development stage I_2). The similar result also obtained by Bardhan *et al.,*(2007) and Patel *et al., (*2012).

Effect of foliar spraying

Pooled results (Table 2) also indicated that root growth rate, stem growth rate, leaf growth rate, pod growth rate, crop growth rate and partitioning percentage were significantly affected due to foliar spraying of organic and inorganic substances. Higher values of root growth rate (0.116 $gm^{-2}day^{-1}$) stem growth rate (1.49 $gm^{-2}day^{-1}$), pod growth rate (5.63 $gm^{-2}day^{-1}$) and crop growth rate (12.33 $gm^{-2}day^{-1}$) of gram were recorded due to spraying of KNO_3 @ 2 % (T_1) at flowering and pod development stage. The leaf growth rate (2.31 $gm^{-2}day^{-1}$) and partitioning percentage (55.15 %) were significantly affected due to spraying of Urea @ 2 % (T_2) and water spray respectively. Kumar *et al.,* (2011), Patil *et al.,* (2012), Singh *et al.,* (2012), (Goud *et al.,* (2014) and Verma *et al.,* (2017) were also obtained similar results.

Interaction effect of I x T

The data of pooled result (Table 2) reveled that stem growth rate, leaf growth rate, pod growth rate and crop growth rate were significantly affected due to combined effect of irrigation and foliar sprays during all the years of experimentation as well as in pooled results. The root growth rate and partitioning percentage were not significantly affected due to combined effect of irrigation and foliar sprays during in pooled results.

Yields and yield attributes

Effect of irrigation

Results (Table 3 and 4) showed that yields (pod, seed, straw and biological) of gram were significantly affected due to level of irrigation in pooled results. On the basis of pooled results maximum pod (2527 kg ha^{-1}), seed (1913 kg ha^{-1}), straw (1028 kg ha^{-1}) and biological yield (3524 kg ha^{-1}) were recorded due to two irrigation (one irrigation at flowering and second at pod development stage (I_2), which were higher by 31.3%, 36.4%, 26.6% and 28.6 percent over their respective one irrigation at flowering stage (I_1). Similarly, seed index, shelling percentage, 100 pod weights and 100 seed weight of gram were also significantly

influenced due to level of irrigation. On the basis of pooled results higher values of seed index (54.56), shelling percentage (76.86 %), 100 pod weight (55.09 g) and 100 seed weight (26.89 g) were obtained with two irrigations (one irrigation at flowering and second at pod development stage I_2 (Table 3 and 4). The maximum harvest index (71.71) and seed index (54.56) were recorded with I_2 one irrigation at flowering and second at pod development stage (Table 1). The findings are close with findings of Bardhan *et al.*, (2007) and Patel *et al.*, (2012).

Effect of foliar spraying

Results (Table 3 and 4) revealed that the yields and yield attributes of gram were significantly differed in pooled result due to foliar spraying of organic and in organic substances.

Table.1 Effect of irrigation and foliar spray treatments on growth parameters in gram (Pooled of 3 years)

Sr. no.	Treatments	RL at 75 DAS (cm)	RL at Maturity (cm)	Plant Height at 75 DAS (cm)	Plant Height at Maturity (cm)	No. of Branches at 75 DAS	No. of Branches at Maturity	Mature pods at 75 DAS	Mature Pods at Maturity
1.1(a). Irrigation (I)									
I_1	One irrigation Flowering stage	10.84	14.11	43.8	45.7	4.93	5.32	6.28	37.52
I_2	One irrigation at Flow. and second at pod developement stage	12.23	15.36	47.7	50.1	6.20	6.77	9.28	51.07
	S. Em. ±	0.20	0.27	1.01	1.03	0.11	0.10	0.37	0.72
	C.D.at 5%	0.70	0.93	3.5	3.6	0.37	0.34	2.26	2.48
	C.V.%	14.0	14.6	17.5	17.1	15.2	13.0	17.2	12.8
1.1 (b). Foliar Spray Treatments (T)									
T_1	KNO_3 @ 2 %	13.27	16.57	48.6	50.7	6.39	7.08	9.74	50.42
T_2	Urea @ 2 %	12.46	15.73	47.3	49.6	6.17	6.70	9.04	48.60
T_3	Varmiwash 100 m	10.88	14.07	45.1	47.0	5.29	5.84	7.08	42.33
T_4	Jivamrut 100 ml/l	11.46	14.68	46.0	47.4	5.52	5.97	7.67	43.79
T_5	Cow urine 100 m	12.20	15.38	46.3	48.9	5.87	6.25	8.43	46.54
T_6	Waters Spray	9.90	13.06	43.1	45.4	4.71	5.09	6.19	38.52
T_7	Control	10.59	13.65	44.1	46.0	5.02	5.38	6.29	39.88
	S. Em. ±	0.42	0.41	1.24	1.30	0.17	0.19	0.42	1.20
	C.D.at 5%	0.70	0.93	3.5	3.6	0.37	0.34	2.77	2.48
1.1 (c). Interaction of I x T									
	S. Em. ±	0.59	0.57	1.75	2.25	0.24	0.26	0.39	1.69
	C.D.at 5%	NS	NS	NS	NS	NS	NS	1.29	NS
	C.V. %	15.4	11.7	11.5	11.5	12.8	13.0	15.0	11.5

Table.2 Effect of irrigation &foliar spraying on physiological growth parameters of gram (Pooled of 3 years)

Sr. no.	Treatments	Root growth rate (gm^{-2} day^{-1})	Stem growth rate (gm^{-2} day^{-1})	Leaf growth rate ($gm^{-2}day^{-1}$)	Pod growth rate (gm^{-2} day^{-1})	Crop growth rate ($gm^{-2}day^{-1}$)	Partitioning percentage
1.1(a). Irrigation (I)							
I_1	One irrigation at Flowe stage	0.053	0.67	1.01	3.29	7.35	44.43
I_2	One irrigation at Flow. and second at pod developement stage	0.118	1.45	2.29	6.03	11.34	52.81
	S. Em. ±	0.002	0.18	0.05	0.39	0.59	0.78
	C.D.at 5%	0.018	0.11	0.26	2.36	3.58	2.70
	C.V.%	17.82	19.03	12.04	15.64	16.37	12.48
1.1 (b). Foliar Spray Treatments (T)							
T_1	KNO_3 @ 2 %	0.116	1.49	2.14	5.63	12.33	45.43
T_2	Urea @ 2 %	0.108	1.19	2.31	5.30	11.10	47.41
T_3	Varmiwash 100 ml/l	0.072	0.93	1.39	4.43	8.58	51.26
T_4	Jivamrut 100 ml/l	0.089	1.05	1.61	4.84	9.58	50.02
T_5	Cow urine 100 ml/l	0.087	1.11	1.67	5.16	10.42	49.00
T_6	Waters Spray	0.058	0.75	1.11	3.46	6.24	55.15
T_7	Control	0.066	0.90	1.32	3.79	7.13	52.87
	S. Em. ±	0.010	0.10	0.09	0.21	0.35	1.15
	C.D.at 5%	0.013	0.20	0.21	1.34	2.04	2.70
1.1 (c). Interaction of I x T							
	S. Em. ±	0.011	0.10	0.13	0.30	0.49	1.63
	C.D.at 5%	NS	0.27	0.39	1.34	2.04	NS
	C.V. %	15.36	16.71	15.05	19.56	15.81	9.80

Table.3 Effect of irrigation and foliar spraying on harvest index and seed index of gram (Pooled of 3 years)

Sr. no.	Treatments	Harvest index	Seed index	Shelling %	100 Pod weight (g)	100 Seed weight (g)
1.1(a). Irrigation (I)						
I_1	One irrigation at Flowe stage	70.09	51.18	74.09	52.47	23.98
I_2	One irrigation at Flow. and second at pod developement stage	71.71	54.56	76.86	55.09	26.89
	S. Em. ±	0.65	0.54	0.33	0.23	0.82
	C.D.at 5%	NS	1.89	1.13	0.81	0.25
	C.V.%	7.31	8.20	3.44	3.45	2.82
1.1 (b). Foliar Spray Treatments (T)						
T_1	KNO_3 @ 2 %	71.96	52.82	78.22	57.50	26.90
T_2	Urea @ 2 %	70.46	52.41	77.36	55.98	26.08
T_3	Varmiwash 100 ml/l	71.09	51.97	74.15	52.43	25.11
T_4	Jivamrut 100 ml/l	71.50	52.87	75.07	53.96	25.41
T_5	Cow urine 100 ml/l	70.51	53.34	76.44	55.23	25.82
T_6	Waters Spray	71.02	53.43	73.08	49.91	24.03
T_7	Control	70.76	0.69	74.01	51.45	24.68
	S. Em. ±	0.98	NS	0.46	0.48	0.32
	C.D.at 5%	NS		1.13	0.81	1.96
1.1 (c). Interaction of I x T						
	S. Em. ±	1.38	0.97	0.65	0.68	0.36
	C.D.at 5%	NS	NS	NS	NS	NS
	C.V. %	5.84	5.52	2.59	3.79	4.23

Table.4 Effect of irrigation and foliar spraying on yield of gram (Pooled of 3 years)

Sr. no.	Treatments	Pod Yield (kg ha^{-1})	Seed Yield (kg ha^{-1})	Straw Yield (kg ha^{-1})	Biological Yield (kg ha^{-1})
1.1(a). Irrigation (I)					
I_1	One irrigation at Flowering	1925	1403	812	2741
I_2	One irrigation at Flow. and second at pod develop. stage	2527	1913	1028	3524
	S. Em. ±	49	29	18	47
	C.D.at 5%	171	100	61	164
	C.V.%	16.9	13.3	15.3	11.5
1.1 (b). Foliar Spray Treatments (T)					
T_1	KNO_3 @ 2 %	2628	1958	1090	3703
T_2	Urea @ 2 %	2477	1838	1043	3510
T_3	Varmiwash 100 ml/l	2103	1542	862	2944
T_4	Jivamrut 100 ml/l	2222	1651	895	3105
T_5	Cow urine 100 ml/l	2371	1785	992	3357
T_6	Waters Spray	1828	1370	747	2561
T_7	Control	1952	1461	810	2748
	S. Em. ±	65	50	30	78
	C.D.at 5%	171	100	61	164
1.1 (c). Interaction of I x T					
	S. Em. ±	92	71	42	110
	C.D.at 5%	NS	NS	NS	NS
	C.V. %	12.0	12.3	13.7	10.1

Table.5 Economics of Chickpea production as influenced by foliar application of organic and inorganic substances under limited water supply

Sr. no.	Treatments	Seed yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})	Gross income (Rs.)	Cost of cultivation (Rs.)	Net income (Rs.)	B:C ratio
Effect of Irrigation (I)							
I_1	One irrigation at Flowering stage	1403	812	42496	18541	23955	2.29
I_2	One irrigation at Flow. and second at pod develop. stage	1913	1028	57904	18691	39213	3.10
Effects of Foliar Spray Treatments (T)							
T_1	KNO_3 @ 2 %	1958	1090	59285	19351	39934	3.06
T_2	Urea @ 2 %	1838	1043	55662	18513	37149	3.01
T_3	Varmiwash 100 ml/l	1542	862	46691	18791	27900	2.48
T_4	Jivamrut 100 ml/l	1651	895	49978	18891	31087	2.65
T_5	Cow urine 100 ml/l	1785	992	54046	18491	35555	2.92
T_6	Waters Spray	1370	747	41474	18441	23033	2.25
T_7	Control	1461	810	44235	18391	25844	-

Maximum pod (2628 kg ha^{-1}), seed (1958 kg ha^{-1}), straw (1090 kg ha^{-1}), biological yield (3703 kg ha^{-1}), shelling percentage (78.22%),100 pod weight (57.50 g)and100 seed weight (26.90 g), were obtained due to foliar spraying of KNO_3 @ 2 % (T_1) at flowering and pod development stage on the basis of pooled results. This was higher by 34.6%, 34.0%, 34.6%, 34.7%, 5.68%, 11.8%, and 9.0% as compared to their respective control. The harvest index and seed index could not significantly affect due to different spraying treatment. These findings are in close conformity with Kumar *et al.,* (2011), Goud *et al.,* (2014), Elamin and Madhvi (2015), Verma *et al.,* (2017) and Yadav *et al.,* (2017).

3(c) Interaction effect of I x T

The yields (pod, seed, straw and biological), harvest index, shelling %, 100 pod weight, 100 seed weight of gram were not significantly affected due to combined effect of irrigation and foliar spray in pooled results. While seed index was significantly affected due to foliar spray in the year 2012.

Economics

Economics was worked out on the basis of pooled result and presented in Table 5. The data indicated that two irrigation (one irrigation at flowering and second at pod development stage I_2) gave the highest gross income (Rs.57904/ha) and net return (Rs.39213/ha). Foliar application with KNO_3 @ 2% at flowering and pod development stage found better in respect of gross income (Rs.59285/ha), net return (Rs.39634/ha) and B:C ratio 3.02.(Goud *et al.*,2014 and Panchal *et al.,* 2017).

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