REPORT

ON

ASSESSMENT OF THE ABSORPTION OF PHOSPHORUS, POTASSIUM AND SODIUM APPLIED THROUGH PSAP BY CHICKPEA CROP

OF

ISHA AGRO SCIENCES PVT. LTD.

(2022)

MACS-AGHARKAR RESEARCH INSTITUTE
G. G. AGARKAR ROAD, PUNE – 411 004 (MS)

दूरभाष/Tel : 020-2532 5000, 2565 3680
फॅक्स/Fax : 020-2565 1542
वेब/Web : www.aripune.org
ई-मेल/E-mail : director@aripune.org

महाराष्ट्र असोसिएशन फॉर द कल्टिव्हेशन ऑफ सायन्स
आघारकर अनुसंधान संस्थान
(विज्ञान और प्रौद्योगिकी विभाग, भारत सरकार के अधिन स्वायत्त संस्थान)
गो. ग. आगरकर पथ, पुणे - ४११ ००४.

Maharashtra Association for the Cultivation of Science
AGHARKAR RESEARCH INSTITUTE
(An Autonomous Body under the Department of Science and Technology, Govt. of India)
G. G. Agarkar Road, Pune - 411 004.

PRODUCT TESTING TRIAL

ON

ASSESSMENT OF THE ABSORPTION OF PHOSPHORUS, POTASSIUM AND SODIUM APPLIED THROUGH PSAP BY CHICKPEA CROP AT MACS-AGHARKAR RESEARCH INSTITUE, PUNE

Title of experiment	:	Assessment of the absorption of Phosphorus and Potassium applied through PSAP by Chickpea crop
Objective:		1) To assess the absorption of nutrients through foliage by Chickpea at various stages of growth
Name and address of the sponsorer	:	ISHA AGRO SCIENCES PVT. LTD., PUNE Sr. No. 17/2C, Ashwamedh Bunglow, Ambedkar Chowk, Shahanu Patel School Road, Warje, Pune 411 058
Location	:	Experimental Farm at Hol-Sortewadi, Tal. Baramati, Dist. Pune of MACS-Agharkar Research Institute, G.G. Agarkar Road, Pune 411 004.
Duration of the project	:	2021-22 (One Year)
Name of scientist	:	Mr. S. A. Jaybhay
Name of Product tested	:	**Potassium Salt of Active Phosphorus (PASP)**
Crop	:	Chickpea
Variety	:	Chickpea- Vikram.
Institute acceptance/ consent letter number	:	3/478/2021/711 Dated 03/01/2022

General Information about the Chickpea field trial conducted

1.	Location	:	ARI, Research Farm, Hol-Sortewadi, Taluka Baramati, District Pune.
2.	Season	:	*Rabi* 2021-22
3.	Crop	:	Chickpea
4.	Variety	:	Vikram
5.	No. of treatments	:	Seven
6.	Design	:	RBD
7.	No. of replications	:	Three
8.	Spacing	:	30 cm between rows and 3-5 cm between two plants
9.	Plot size	:	2 m x 2.1 m
10.	Date of sowing	:	21/12/2021
11.	Date of harvest	:	12/04/ 2022
12.	Recommended dose of fertilizer	:	25:50:30 kg NPK/ha
13.	Product under testing applied	:	Potassium Salt of Active Phosphorus (PSAP) as per treatments given in Table 1
14.	Method of application	:	Foliar application at 30, 45 and 60 days after sowing
15.	Previous crop	:	Soybean
16.	Soil type	:	Medium black
17.	Irrigations given	:	Five
18.	Initial soil nutrition status (OC%, Available P & K kg/ha)	:	
19.	Occurrence of diseases	:	Nil
20.	Occurrence of insect-pests	:	Nil
21.	Plant protection measures		

PH	EC	OC	N	P	K
7.53	0.35 (dS/m)	(%) 0.74	199.36 kg/ha	47.71 kg/ha	448 kg/ha

i) Seed treatment	:	Seed treatment with Carbendazim 3 g/kg seed
ii) Soil application of insecticides/ fungicides	:	Nil
iii) Post emergence application of insecticides/fungicides	:	
iv) Sprayer used	:	HTP Sprayer

Table 1: Treatment wise dose of fertilizers & quantity of fertilizers to be used with time of application.

Sr. No.	Treatments (per plot)	Treatments (per ha)
1.	T1: RDF + PSAP 4 g /lit. water	T1: RDF + PSAP 2 kg / 500 lit. water
2.	T2: RDF + PSAP 6 g /lit. water	T2: RDF + PSAP 3 kg /500 lit. water
3.	T3: RDF + 19:19:19 4 g /lit. water	T1: RDF + 19:19:19 2 kg / 500 lit. water
4.	T4: RDF + 19:19:19 6 g/lit water	T2: RDF + 19:19:19 3 kg /500 lit. water
5.	T5: RDF + 00:52:34 4 g/lit water	T1: RDF + 0:52:34 2 kg / 500 lit. water
6.	T6: RDF + 00:52:34 6 g/lit water	T2: RDF + 0:52:34 3 kg /500 lit. water
7.	T7: RDF + Water spray (Control)	T7: RDF + Water spray (Control)

Foliar sprays after 30, 45 and 60 days after sowing (DAS).

Table 2: Quantity of nutrients applied through spray

Treatment	Dose (g/lit)	Dose (kg/ha)	Quantity of Nutrient (kg/ha)	
			P2O5	K2O
T1: RDF + PSAP 4 g /lit. water	4	2.00	0.8	0.8
T2: RDF + PSAP 6 g /lit. water	6	3.00	1.2	1.2
T3: RDF + 19:19:19 4 g /lit. water	4	2.00	0.38	0.38
T4: RDF + 19:19:19 6 g/lit water	6	3.00	0.57	0.57
T5: RDF + 00:52:34 4 g/lit water	4	2.00	1.04	0.68
T6: RDF + 00:52:34 6 g/lit water	6	3.00	1.56	1.02
T7: RDF + Water spray (Control)	-	-	-	-

Details of Observations: Biometric observations on plant height, number of branches per plant and dry matter per plant were recorded on randomly selected five plants per plot. Yield attributing traits *viz.*, number of pods per plant, yield per plot and biological yield was recorded. Available soil nutritional status of the representative soil sample from experimental plot was determined before sowing. Nutrient absorption was determined by analyzing the plant samples for P, K & Na nutrient and arsenic and lead elemental content and before 30, 45 and 60 DAS and after 30, 45 and 60 DAS, respectively.

TABLE 3: EFFECT ON GROWTH ATTRIBUTES OF CHICKPEA

Location: MACS-ARI Hol Farm, Baramati, Distt. Pune

Variety: Vikram

Treatments	Increase in dry matter content (g/plant) after application			Dry matter (g) per plant			Crop growth rate		Relative growth rate	
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	30-45 DAS	45-60 DAS	30-45 DAS	45-60 DAS
T1: RDF + PSAP 4 g /lit. water	4.31	0.87	8.20	5.81	7.26	27.27	0.970	1.334	0.0063	0.0384
T2: RDF + PSAP 6 g /lit. water	4.75	0.93	8.20	6.17	8.26	30.00	0.139	1.449	0.0082	0.0375
T3: RDF + 19:19;19 4 g /lit. water	4.16	1.22	9.40	5.44	7.54	29.87	0.140	1.489	0.0096	0.3095
T4: RDF + 19:19:19 6 g/lit water	4.09	0.87	6.73	5.13	6.87	32.53	0.116	1.711	0.0083	0.04513
T5: RDF + 0:52:34 4 g/lit water	5.19	1.31	8.27	6.22	7.88	30.00	0.111	1.474	0.0070	0.0385
T6: RDF + 0:52:34 6 g/lit water	3.78	0.74	9.80	4.75	6.56	28.93	0.121	1.491	0.0096	0.0430
T7: RDF + Water spray (Control)	5.18	0.69	5.87	6.12	7.51	30.80	0.930	1.552	0.0057	0.0408
SE m	1.64	1.84	6.94	0.371	0.512	1.921	0.034	0.141	0.0021	0.0031
CD at 0.05%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

TABLE 4: YIELD RESPONSE OF CHICKPEA TO PSAP

Location: MACS-ARI Hol Farm, Baramati, Distt. Pune

Variety: Vikram

Treatments	Plant height (cm)	No. of pods/ plant	Branches/ plant	Harvest index (%)	Seed index (g)	Seed yield (kg/plot)	Seed yield (kg/ha)
T1: RDF + PSAP 4 g /lit. water	58.67	93.67	12.67	36.12	20.00	1.17	2774
T2: RDF + PSAP 6 g /lit. water	58.67	103.00	12.00	36.73	21.67	1.22	2910
T3: RDF + 19:19;19 4 g /lit. water	58.33	83.33	12.67	34.07	19.67	1.09	2596
T4: RDF + 19:19:19 6 g/lit water	56.33	85.33	12.67	35.65	20.00	1.09	2598
T5: RDF + 0:52:34 4 g/lit water	59.67	90.67	13.33	35.10	20.00	1.10	2611
T6: RDF + 0:52:34 6 g/lit water	58.67	95.33	13.00	35.98	20.33	1.13	2701
T7: RDF + Water spray (Control)	54.33	76.33	10.67	37.60	18.67	1.02	2437
SE m	3.171	2.31	1.521	2.024	0.44	0.03	66.10
CD at 0.05%	NS	7.10	NS	NS	1.37	0.08	203.56

TABLE 5: NUTRIENT ABSORPTION (%) BY CHICKPEA BEFORE AND AFTER FOLIAR APPLICATION

Location: MACS-ARI Hol Farm, Baramati, Distt. Pune

Variety: Vikram

Treatments	Phosphorus (%)		Potassium (%)		Sodium (%)		Phosphorus (%)		Potassium (%)		Sodium (%)		Phosphorus (%)		Potassium (%)		Sodium (%)		Arsenic (ppm)	Lead (ppm)
	30 DBA	30 DAA	30 DBA	30 DAA	30 DBA	30 DAA	45 DBA	45 DAA	45 DBA	45 DAA	45 DBA	45 DAA	60 DBA	60 DAA	60 DBA	60 DAA	60 DBA	60 DAA	60 DBA	60 DAA
T1: RDF + PSAP 4 g /lit. water	0.46	0.48	3.32	2.42	0.68	0.22	0.42	0.44	2.47	1.73	0.12	0.28	0.36	0.36	1.77	1.75	0.41	0.18	< 1.0	<0.5
T2: RDF + PSAP 6 g /lit. water	0.40	0.49	3.20	2.66	0.77	0.42	0.38	0.52	2.55	1.87	0.20	0.34	0.36	0.37	1.60	1.73	0.37	0.28	< 1.0	<0.5
T3: RDF + 19:19;19 4 g/lit. water	0.44	0.45	3.08	2.20	0.69	0.46	0.41	0.48	2.37	1.47	0.20	0.31	0.39	0.38	1.58	2.12	0.27	0.22	< 1.0	<0.5
T4: RDF + 19:19:19 6 g/lit water	0.41	0.43	3.23	2.83	0.59	0.41	0.42	0.43	2.33	1.51	0.17	0.34	0.36	0.41	1.68	1.92	0.32	0.30	< 1.0	<0.5
T5: RDF + 0:52:34 4 g/lit water	0.46	0.47	3.25	2.88	0.61	0.40	0.43	0.53	2.53	1.70	0.22	0.27	0.42	0.41	1.77	2.22	0.28	0.27	< 1.0	<0.5
T6: RDF + 0:52:34 6 g/lit water	0.45	0.44	3.27	2.35	0.62	0.37	0.38	0.45	1.95	1.43	0.17	0.22	0.36	0.37	1.48	1.68	0.33	0.17	< 1.0	<0.5
T7: RDF + Water spray (Control)	0.45	0.41	3.37	2.32	0.61	0.35	0.41	0.43	2.40	1.68	0.22	0.35	0.40	0.35	1.65	1.77	0.31	0.22	< 1.0	<0.5
SE m	0.020	0.022	0.176	0.293	0.045	0.090	0.027	0.018	0.257	0.112	0.048	0.046	0.022	0.025	0.161	0.236	0.049	0.037		
CD at 0.05%	NS	NS	NS	NS	NS	NS	NS	0.055	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS		

DBA: Days before application, DAA: Days after application

TABLE 6: NUTRIENT UPTAKE, SOIL NUTRITIONAL STATUS AND NUTRIENT BALANCE SHEET

Location: MACS-ARI Hol Farm, Baramati, Distt. Pune Variety: Vikram

Initial Soil Nutrition Status	P (kg/ha)	K (kg/ha)	Na (kg/ha)
	47.71	448	0.25

Treatments	Nutrient Uptake			Nutrients Applied		Nutrient Removal			Available soil nutrients status			Gain/ Loss		
	P (kg/ha)	K (kg/ha)	Na (kg/ha)	P (kg/ha)	K (kg/ha)	P (kg/ha)	K (kg/ha)	Na (kg/ha)	P (kg/ha)	K (kg/ha)	Na (kg/ha)	P (kg/ha)	K (kg/ha)	Na (kg/ha)
T1: RDF + PSAP 4 g /lit. water	27.86	135.42	13.93	52.826	33.384	63.79	162.50	0.0014	46.5	415	0.289	-1.21	-33	0.039
T2: RDF + PSAP 6 g /lit. water	29.69	138.81	22.47	54.239	35.075	67.99	166.57	0.0022	44.52	421	0.260	-3.19	-27	0.010
T3: RDF + 19:19;19 4 g/lit. water	29.04	162.03	16.81	51.702	31.911	66.51	194.43	0.0017	42.5	418	0.240	-5.21	-30	-0.01
T4: RDF + 19:19:19 6 g/lit water	29.87	139.89	21.86	52.553	32.867	68.41	167.86	0.0022	43.2	429	0.237	-4.51	-19	-0.013
T5: RDF + 0:52:34 4 g/lit water	30.85	167.03	20.31	54.385	32.883	70.64	200.43	0.0020	40.65	417	0.282	-7.06	-31	0.032
T6: RDF + 0:52:34 6 g/lit water	27.93	126.80	12.83	56.577	34.324	63.95	152.16	0.0013	45.5	408	0.255	-2.21	-40	0.005
T7: RDF + Water spray (Control)	23.00	116.31	14.46	50.000	30.000	52.67	139.58	0.0014	39.5	410	0.236	-8.21	-38	-0.014

TABLE 7: Nutrient and element content of soil before sowing and after harvest

Representative soil sample	Before sowing		
	Arsenic (ppb)	Lead (ppb)	Organic carbon (%)
	BDL	9.10	0.59
Treatments	**After harvest**		
	Arsenic (ppb)	**Lead (ppb)**	**Organic carbon (%)**
T1: RDF + PSAP 4 g /lit. water	BDL	11.4	0.54
T2: RDF + PSAP 6 g /lit. water	BDL	11.5	0.58
T3: RDF + 19:19;19 4 g /lit. water	BDL	11.1	0.51
T4: RDF + 19:19:19 6 g/lit water	BDL	8.20	0.57
T5: RDF + 0:52:34 4 g/lit water	BDL	11.8	0.58
T6: RDF + 0:52:34 6 g/lit water	BDL	7.97	0.59
T7: RDF + Water spray (Control)	BDL	12.3	0.60

BDL: Below detectable level; ppb: parts per billion

TABLE 8: Quantification of phosphorus and potash removal from soil

Tr. No.	Treatments	Initial soil available P (kg/ha)	After harvest soil available P (kg/ha)	P Removal from soil (kg/ha)	Initial soil available K (kg/ha)	After harvest soil available K (kg/ha)	K Removal from soil (kg/ha)
1	RDF + PSAP 4 g /lit. water	47.71	46.5	**1.21**	448	415	**33**
2	RDF + PSAP 6 g /lit. water	47.71	44.52	**3.19**	448	421	**27**
3	RDF + 19:19;19 4 g/lit. water	47.71	42.5	**5.21**	448	418	**30**
4	RDF + 19:19:19 6 g/lit water	47.71	43.2	**4.51**	448	429	**19**
5	RDF + 0:52:34 4 g/lit water	47.71	40.65	**7.06**	448	417	**31**
6	RDF + 0:52:34 6 g/lit water	47.71	45.5	**2.21**	448	408	**40**
7	RDF + Water spray (Control)	47.71	39.5	**8.21**	448	410	**38**

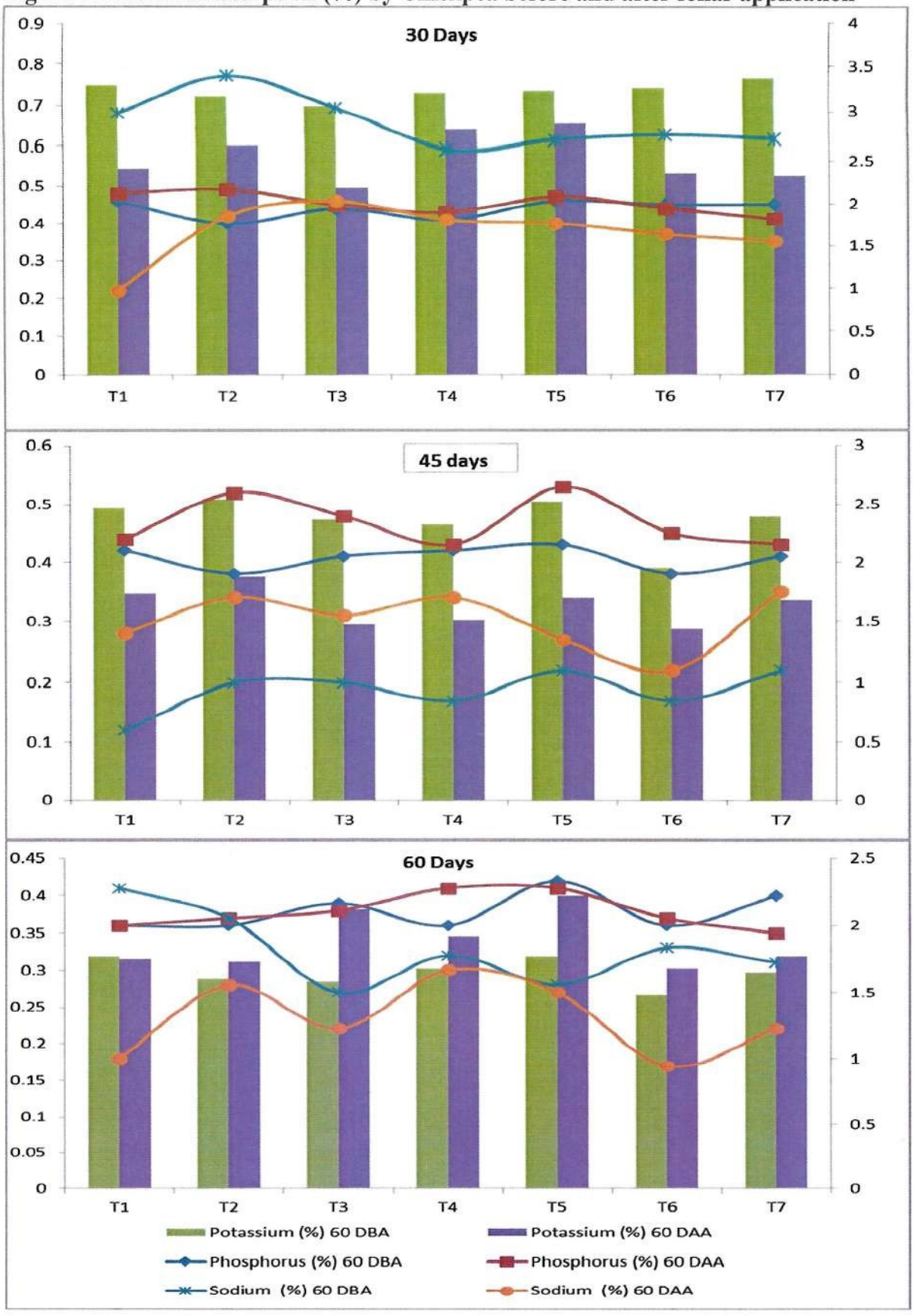
TABLE 9: Phosphorus and potash uptake from foliar spray of fertilizer

Tr No	Treatments	Total P uptake (kg/ha)	Contribution of soil (kg/ha)	P uptake due to fertilizers (kg/ha)	P uptake from soil applied fertilizer (kg/ha)	P uptake due to foliar spray of fertilizer (kg/ha)	Total K uptake (kg/ha)	Contribution of soil (kg/ha)	K uptake due to fertilizers (kg/ha)	K uptake from soil applied fertilizer (kg/ha)	K uptake due to foliar spray of fertilizer (kg/ha)
A	b	C	d *i.e.* nutrient removal from soil	e *i.e. c-d*	f *i.e.* P uptake of T7	G	c	d *i.e.* nutrient removal from soil	e *i.e. c-d*	f *i.e.* P uptake of T7	g
1	RDF + PSAP 4 g /lit. water	27.86	1.21	26.65	14.79	11.86	135.42	33	102.42	78.31	24.11
2	RDF + PSAP 6 g /lit. water	29.69	3.19	26.50	14.79	11.71	138.81	27	111.81	78.31	33.50
3	RDF + 19:19;19 4 g/lit. water	29.04	5.21	23.83	14.79	9.04	162.03	30	132.03	78.31	**53.72**
4	RDF + 19:19:19 6 g/lit water	29.87	4.51	25.36	14.79	10.57	139.89	19	120.89	78.31	42.58
5	RDF + 0:52:34 4 g/lit water	30.85	7.06	23.79	14.79	9.00	167.03	31	136.03	78.31	**57.72**
6	RDF + 0:52:34 6 g/lit water	27.93	2.21	25.72	14.79	10.93	126.8	40	86.80	78.31	8.49
7	RDF + Water spray (Control)	23.00	8.21	14.79	14.79		116.31	38	78.31	78.31	0.00

Table 10: Effect of PSAP on yield, nutrient uptake and Physiological Nutrient Use Efficiency of P & K in chickpea

Tr. No.	Treatments	Grain yield (kg/ha)	Nutrient Uptake (kg/ha)		Physiological Nutrient Use Efficiency	
			P	K	P	K
1.	RDF + PSAP 4 g /lit. water	2774	27.86	135.42	**69.34**	17.63
2.	RDF + PSAP 6 g /lit. water	2910	29.69	138.81	**70.70**	21.02
3.	RDF + 19:19;19 4 g /lit. water	2596	29.04	162.03	26.32	3.48
4.	RDF + 19:19:19 6 g/lit water	2598	29.87	139.89	23.44	6.83
5.	RDF + 0:52:34 4 g/lit water	2611	30.85	167.03	22.17	3.43
6.	RDF + 0:52:34 6 g/lit water	2701	27.93	126.80	53.55	25.17
7.	RDF + Water spray (Control)	2437	23.00	116.31	69.34	17.63
	SE m	66.10				
	CD at 0.05%	203.56				

Figure 1: Nutrient Absorption (%) by Chickpea before and after foliar application



Results:

Effect on growth attributes:

Results of an experimental trial presented in Table 3. The results revealed that, the differences for growth attributes *viz.*, difference in plant dry matter content before treatment and after application of the treatments, plant dry matter per plant at 30, 45 and 60 days after sowing (DAS), crop growth rate (CGR) and relative growth rate (RGR) at 30-45 and 45-60 DAS were non-significant in various treatments studied. Similarly, the plant height at harvest and number of branches per plant was non significantly different among the treatments.

Effect on yield and its attributes:

Among the yield and its attributes number of pods per plant, seed yield per plot, seed index and seed yield per quintal were significantly different due to various treatments under the study (Table 4). Number of pods per plant were significantly higher in the treatment T2- RDF + PSAP 6 g/lit. water (103 pods/plant) over rest of the treatments and was followed by T6- RDF + 0:52:34 6g/lit. water (95 pods/plant) and T1- RDF + PSAP 4 g/lit water (94 pods/plant). The seed yield was significantly higher under treatment T2- RDF + PSAP 6 g/lit. water (2910 kg/ha) over rest of the treatments except T1- RDF + PASAP 4g /lit water (2774 kg/ha). Least seed yield was obtained with T7- RDF + water spray (2437 kg/ha). Increase in seed yield of chickpea in treatment T2- RDF + PSAP 6 g/lit. water was 19.41% over T7- RDF + water spray (control).

Effect of soil nutrition status and nutrient absorption by crop:

The data on the nutrient absorption at 30, 45 and 60 days after sowing by plants is presented in Table 5. It showed that, the differences for nutrient absorption values at three stages (30, 45 & 60 DBS and DAA) were non significantly different due to various treatments of foliar application to chickpea except for phosphorus absorption at 45 days after application. Phosphorus absorption at 45 days after application was high in treatment T5- RDF + 0:52:34

4 g/lit water (0.53 %) over rest of the treatments and was followed by T2- RDF + PSAP 6 g/lit. water (0.52%). From the data of Arsenic and Lead absorption, it was observed that values are less than 1 and 0.5%, respectively. Whereas, the nutrient and element content of the soil before sowing and after harvest showed non consistent trend between the different treatments studied. This might be due to the first year of testing.

Nutrient uptake, Soil nutrition status and nutrient balance sheet:

Uptake of nutrients by crop is a function of the nutrient content in plant and dry matter accumulation per unit area. The values for the nutrient uptake and soil nutrition status (available nutrients) showed inconsistent trend among the treatments (Table 6). However, the nutrient balance sheet showed that the phosphorus and potassium have net loss in different treatments including untreated control, except for sodium. Thus, it is revealed that intermediate imbalance and loss of nutrients was observed under the treatments studied.

Quantification of the phosphorus and potash removal by plant from soil and its uptake due to foliar application of the fertilizers:

Phosphorus and potash removal by chickpea from soil (Table 8) showed comparable differences among the different treatments, however the maximum removal of phosphorus from soil was with treatment RDF + Water spray (8.21 kg/ha), followed by RDF + 0:52:34 4 gm/lit (7.06 kg/ha) of water and RDF + 19:19:19 4 gm/lit of water (5.21 kg/ha) of water. The potash removal from soil was maximum in RDF + 0:52:34 6 g/lit water (40 kg/ha) and RDF + Water spray (38 kg/ha) followed by RDF + PSAP 4 g/lit of water. The treatments under study have not showed the any association with the application of different sources of fertilizers with the nutrient removal by chickpea from soil.

Uptake of phosphorus due to foliar application of fertilizers (Table 9) showed the RDF + foliar application of PSAP 4 g/lit of water (11.86 kg/ha) has maximum uptake of phosphorus followed by 6 g/lit of water (11.71 kg/ha) among the different treatments studied. It has

evidenced that the foliar application of PSAP (4 g and 6 g/ lit of water) has aid in uptake of phosphorus to be utilized by the chickpea for its growth and development. Potassium uptake due to foliar application of fertilizers was maximum with treatments RDF + 0:52:34 6 g/lit of water (57.72 kg/ha) and RDF + 19:19:19 4 g/lit of water (53.72 kg/ha). Whereas, RDF + PSAP 6 g/lit of water has recorded 33.50 kg/ha potassium uptake.

Physiological nutrient use efficiency:

Physiological nutrient use efficiency of Phosphorus and potassium in terms of ability of plant to transform nutrients acquired from fertilizer into economic yield was maximum with treatments containing RDF + PSAP 4 and 6 g /lit water (Table 10). Improved Phosphorus uptake and physiological nutrient use efficiency due to PSAP evidenced the improvement in chickpea yield.

10.01.23

संतोष जायभाय/ Santosh Jaybhay
वैज्ञानिक / Scientist
अनुवंशिकी एवं पौध प्रजनन / Genetics and Plant Breeding
आगरकर अनुसंधान संस्थान / Agharkar Research Institute
गो.ग. आगरकर मार्ग, पुणे-४११००४ /
G.G. Agarkar Road, Pune-411004

View of field trial at ARI Hol Farm