

Table 4.1. Effect of phosphorus, sulphur and seaweed sap on plant height of chickpea

Treatment	30 DAS			60 DAS			At harvest		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)									
20	12.75	12.14	12.45	34.87	34.97	34.92	52.40	53.37	52.89
40	14.53	14.20	14.36	37.72	37.76	37.74	55.30	56.12	55.71
60	14.75	14.56	14.65	37.77	38.43	38.10	57.65	56.87	57.26
S.Em.±	0.24	0.21	0.16	0.61	0.69	0.46	0.88	0.87	0.62
CD (P=0.05)	0.73	0.64	0.47	1.83	2.06	1.32	2.63	2.60	1.78
Sulphur levels (S kg ha⁻¹)									
00	12.59	13.03	12.81	34.40	34.57	34.49	52.51	52.93	52.72
20	14.42	13.88	14.15	37.12	37.75	37.43	56.22	56.52	56.37
40	15.01	13.98	14.50	38.83	38.84	38.83	56.61	56.92	56.76
S.Em.±	0.24	0.21	0.16	0.61	0.69	0.46	0.88	0.87	0.62
CD (P=0.05)	0.73	0.64	0.47	1.83	2.06	1.32	2.63	2.60	1.78
Seaweed sap spray									
Control	13.93	13.67	13.80	33.45	34.14	33.79	53.02	53.47	53.24
<i>Kappaphycus</i> sap (10%)	14.05	13.69	13.87	38.49	38.56	38.52	56.53	56.79	56.66
<i>Gracilaria</i> sap (10%)	14.04	13.54	13.79	38.42	38.46	38.44	55.80	56.11	55.95
S.Em.±	0.15	0.18	0.12	0.41	0.58	0.35	0.50	0.48	0.35
CD (P=0.05)	NS	NS	NS	1.17	1.66	1.00	1.45	1.38	0.98

Table 4.2. Effect of phosphorus, sulphur and seaweed sap on number of primary branches plant⁻¹ of chickpea

Treatment	60 DAS			At harvest		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)						
20	3.43	3.30	3.36	3.13	3.16	3.14
40	3.57	3.69	3.63	3.43	3.38	3.41
60	3.63	3.74	3.68	3.50	3.40	3.45
S.Em.±	0.04	0.05	0.03	0.06	0.06	0.04
CD (P=0.05)	0.11	0.14	0.09	0.19	0.18	0.13
Sulphur levels (S kg ha⁻¹)						
00	3.24	3.19	3.22	3.08	3.11	3.10
20	3.61	3.73	3.67	3.46	3.39	3.43
40	3.77	3.81	3.79	3.51	3.44	3.47
S.Em.±	0.04	0.05	0.03	0.06	0.06	0.04
CD (P=0.05)	0.11	0.14	0.09	0.19	0.18	0.13
Seaweed sap spray						
Control	3.20	3.09	3.14	3.11	3.10	3.11
<i>Kappaphycus</i> sap (10%)	3.95	3.99	3.97	3.51	3.46	3.48
<i>Gracilaria</i> sap (10%)	3.47	3.65	3.56	3.44	3.38	3.41
S.Em.±	0.02	0.03	0.02	0.05	0.05	0.03
CD (P=0.05)	0.07	0.09	0.06	0.15	0.13	0.10

Table 4.4. Effect of phosphorus, sulphur and seaweed sap on dry matter accumulation at 60 DAS of chickpea

Treatments	Leaf (g plant ⁻¹)			Stem (g plant ⁻¹)			Reproductive parts (g plant ⁻¹)			Total (g plant ⁻¹)		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)												
20	3.915	3.996	3.955	1.882	1.851	1.866	1.123	1.119	1.121	6.920	6.965	6.943
40	4.063	4.125	4.094	2.065	2.099	2.082	1.208	1.241	1.225	7.335	7.466	7.401
60	4.174	4.240	4.207	2.220	2.234	2.227	1.313	1.305	1.309	7.707	7.779	7.743
S.Em.±	0.052	0.047	0.035	0.037	0.021	0.021	0.019	0.008	0.010	0.104	0.052	0.058
CD (P=0.05)	0.156	0.140	0.101	0.111	0.064	0.062	0.056	0.024	0.029	0.311	0.157	0.167
Sulphur levels (S kg ha⁻¹)												
00	3.853	3.999	3.926	1.736	1.723	1.730	1.122	1.131	1.127	6.711	6.853	6.782
20	4.115	4.145	4.130	2.188	2.214	2.201	1.249	1.260	1.255	7.552	7.620	7.586
40	4.183	4.216	4.200	2.243	2.247	2.245	1.272	1.274	1.273	7.698	7.737	7.718
S.Em.±	0.052	0.047	0.035	0.037	0.021	0.021	0.019	0.008	0.010	0.104	0.052	0.058
CD (P=0.05)	0.156	0.140	0.101	0.111	0.064	0.062	0.056	0.024	0.029	0.311	0.157	0.167
Seaweed sap spray												
Control	3.840	3.933	3.886	1.771	1.759	1.765	1.115	1.122	1.118	6.725	6.813	6.769
<i>Kappaphycus</i> sap (10%)	4.248	4.337	4.293	2.209	2.230	2.220	1.297	1.302	1.299	7.755	7.869	7.812
<i>Gracilaria</i> sap (10%)	4.063	4.091	4.077	2.186	2.196	2.191	1.232	1.242	1.237	7.482	7.529	7.506
S.Em.±	0.033	0.037	0.025	0.022	0.014	0.013	0.011	0.007	0.007	0.060	0.046	0.038
CD (P=0.05)	0.095	0.107	0.070	0.064	0.040	0.037	0.032	0.021	0.019	0.173	0.131	0.107

Table 4.5. Effect of phosphorus, sulphur and seaweed sap on dry matter accumulation at 90 DAS of chickpea

Treatments	Leaf (g plant ⁻¹)			Stem (g plant ⁻¹)			Reproductive parts (g plant ⁻¹)			Total (g plant ⁻¹)		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)												
20	2.309	2.389	2.349	4.959	4.937	4.948	6.495	6.651	6.573	13.763	13.977	13.870
40	2.710	2.736	2.723	5.442	5.407	5.424	7.199	7.284	7.241	15.351	15.426	15.389
60	2.822	2.830	2.826	5.641	5.590	5.615	7.938	7.914	7.926	16.400	16.333	16.367
S.Em.±	0.039	0.046	0.030	0.068	0.056	0.044	0.115	0.074	0.068	0.213	0.110	0.120
CD (P=0.05)	0.118	0.138	0.087	0.203	0.167	0.126	0.344	0.222	0.197	0.640	0.330	0.346
Sulphur levels (S kg ha⁻¹)												
00	2.326	2.352	2.339	4.924	4.934	4.929	6.545	6.628	6.587	13.795	13.914	13.854
20	2.604	2.667	2.636	5.454	5.414	5.434	7.451	7.480	7.465	15.509	15.561	15.535
40	2.911	2.935	2.923	5.663	5.586	5.625	7.636	7.740	7.688	16.211	16.261	16.236
S.Em.±	0.039	0.046	0.030	0.068	0.056	0.044	0.115	0.074	0.068	0.213	0.110	0.120
CD (P=0.05)	0.118	0.138	0.087	0.203	0.167	0.126	0.344	0.222	0.197	0.640	0.330	0.346
Seaweed sap spray												
Control	2.403	2.463	2.433	5.035	5.041	5.038	6.631	6.750	6.690	14.068	14.253	14.161
<i>Kappaphycus</i> sap (10%)	2.747	2.777	2.762	5.536	5.465	5.500	7.641	7.700	7.670	15.924	15.941	15.932
<i>Gracilaria</i> sap (10%)	2.691	2.715	2.703	5.471	5.429	5.450	7.361	7.399	7.380	15.522	15.542	15.532
S.Em.±	0.025	0.032	0.020	0.049	0.047	0.034	0.074	0.059	0.048	0.132	0.086	0.079
CD (P=0.05)	0.071	0.091	0.057	0.140	0.136	0.096	0.214	0.170	0.134	0.379	0.248	0.223

Table 4.6. Effect of phosphorus, sulphur and seaweed sap on dry matter accumulation at harvest of chickpea

Treatments	Leaf (g plant ⁻¹)			Stem (g plant ⁻¹)			Reproductive parts (g plant ⁻¹)			Total (g plant ⁻¹)		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)												
20	2.524	2.621	2.572	5.232	5.189	5.210	6.950	7.116	7.033	14.705	14.926	14.816
40	2.957	2.993	2.975	5.721	5.677	5.699	8.003	8.094	8.048	16.681	16.764	16.723
60	3.061	3.102	3.082	5.893	5.820	5.857	8.066	8.240	8.153	17.020	17.162	17.091
S.Em.±	0.044	0.044	0.031	0.068	0.057	0.044	0.103	0.079	0.065	0.201	0.115	0.116
CD (P=0.05)	0.132	0.131	0.089	0.204	0.170	0.128	0.309	0.235	0.187	0.603	0.344	0.334
Sulphur levels (S kg ha⁻¹)												
00	2.520	2.569	2.544	5.195	5.181	5.188	7.003	7.092	7.048	14.718	14.842	14.780
20	2.843	2.919	2.881	5.727	5.685	5.706	7.979	8.003	7.991	16.549	16.607	16.578
40	3.178	3.229	3.204	5.924	5.820	5.872	8.037	8.354	8.195	17.139	17.403	17.271
S.Em.±	0.044	0.044	0.031	0.068	0.057	0.044	0.103	0.079	0.065	0.201	0.115	0.116
CD (P=0.05)	0.132	0.131	0.089	0.204	0.170	0.128	0.309	0.235	0.187	0.603	0.344	0.334
Seaweed sap spray												
Control	2.621	2.690	2.655	5.301	5.293	5.297	7.077	7.222	7.150	14.999	15.205	15.102
<i>Kappaphycus</i> sap (10%)	2.983	3.044	3.014	5.799	5.738	5.768	8.072	8.211	8.141	16.854	16.993	16.923
<i>Gracilera</i> sap (10%)	2.938	2.983	2.960	5.747	5.655	5.701	7.869	8.017	7.943	16.554	16.654	16.604
S.Em.±	0.027	0.029	0.020	0.045	0.055	0.036	0.077	0.072	0.053	0.132	0.106	0.085
CD (P=0.05)	0.079	0.083	0.056	0.130	0.158	0.100	0.220	0.206	0.148	0.378	0.305	0.239

Table 4.7. Effect of phosphorus, sulphur and seaweed sap on crop growth rate and absolute growth rate of chickpea

Treatment	Crop growth rate (g m ⁻² day ⁻¹)						Absolute growth rate (g plant ⁻¹ day ⁻¹)					
	30-60 DAS			60-90 DAS			30-60 DAS			60-90 DAS		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)												
20	5.831	5.886	5.859	6.912	7.083	6.998	0.192	0.194	0.193	0.228	0.234	0.231
40	6.181	6.299	6.240	8.097	8.041	8.069	0.204	0.208	0.206	0.267	0.265	0.266
60	6.553	6.614	6.584	8.781	8.640	8.711	0.216	0.218	0.217	0.290	0.285	0.287
S.Em.±	0.092	0.055	0.053	0.126	0.075	0.073	0.003	0.002	0.002	0.004	0.002	0.002
CD (P=0.05)	0.275	0.164	0.154	0.378	0.224	0.211	0.009	0.005	0.005	0.012	0.007	0.007
Sulphur levels (S kg ha⁻¹)												
00	5.661	5.794	5.727	7.155	7.132	7.143	0.187	0.191	0.189	0.236	0.235	0.236
20	6.384	6.450	6.417	8.037	8.022	8.029	0.211	0.213	0.212	0.265	0.265	0.265
40	6.520	6.555	6.538	8.598	8.610	8.604	0.215	0.216	0.216	0.284	0.284	0.284
S.Em.±	0.092	0.055	0.053	0.126	0.075	0.073	0.003	0.002	0.002	0.004	0.002	0.002
CD (P=0.05)	0.275	0.164	0.154	0.378	0.224	0.211	0.009	0.005	0.005	0.012	0.007	0.007
Seaweed sap spray												
Control	5.580	5.655	5.618	7.417	7.515	7.466	0.184	0.187	0.185	0.245	0.248	0.246
<i>Kappaphycus</i> sap (10%)	6.629	6.743	6.686	8.252	8.154	8.203	0.219	0.223	0.221	0.272	0.269	0.271
<i>Gracilaria</i> sap (10%)	6.356	6.402	6.379	8.121	8.094	8.108	0.210	0.211	0.211	0.268	0.267	0.268
S.Em.±	0.053	0.051	0.037	0.090	0.069	0.057	0.002	0.002	0.001	0.003	0.002	0.002
CD (P=0.05)	0.151	0.145	0.103	0.259	0.199	0.160	0.005	0.005	0.003	0.009	0.007	0.005

Table 4.8. Effect of phosphorus, sulphur and seaweed sap on relative growth rate and biomass duration of chickpea

Treatment	Relative growth rate (g g ⁻¹ day ⁻¹)						Biomass duration (g days)					
	30-60 DAS			60-90 DAS			30-60 DAS			60-90 DAS		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)												
20	0.0259	0.0261	0.0260	0.0098	0.0099	0.0098	121	122	121	310	314	312
40	0.0264	0.0265	0.0265	0.0108	0.0106	0.0107	128	130	129	340	343	342
60	0.0265	0.0265	0.0265	0.0112	0.0110	0.0111	134	135	135	362	362	362
S.Em.±	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	2	1	1	5	2	3
CD (P=0.05)	0.0003	NS	0.0003	0.0002	0.0002	0.0001	5	2	3	14	7	8
Sulphur levels (S kg ha⁻¹)												
00	0.0259	0.0261	0.0260	0.0103	0.0101	0.0102	117	120	118	308	312	310
20	0.0264	0.0265	0.0264	0.0107	0.0107	0.0107	132	133	132	346	348	347
40	0.0264	0.0265	0.0265	0.0108	0.0108	0.0108	134	135	134	359	360	359
S.Em.±	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	2	1	1	5	2	3
CD (P=0.05)	0.0003	NS	0.0003	0.0002	0.0002	0.0001	5	2	3	14	7	8
Seaweed sap spray												
Control	0.0248	0.0249	0.0249	0.0104	0.0104	0.0104	119	120	120	312	316	314
<i>Kappaphycus</i> sap (10%)	0.0268	0.0270	0.0269	0.0108	0.0106	0.0107	134	136	135	355	357	356
<i>Gracilaria</i> sap (10%)	0.0271	0.0272	0.0271	0.0106	0.0105	0.0106	130	131	130	345	346	346
S.Em.±	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	1	1	1	3	2	2
CD (P=0.05)	0.0002	0.0004	0.0002	0.0002	NS	0.0002	3	2	2	8	5	5

Table 4.9. Effect of phosphorus, sulphur and seaweed sap on yield attributes of chickpea

Treatments	Pods plant ⁻¹			Grains pod ⁻¹			Grains plant ⁻¹			Grain yield plant ⁻¹ (g)			100-grain weight (g)		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)															
20	39.32	38.86	39.09	1.32	1.32	1.32	45.90	45.71	45.80	5.44	5.30	5.37	13.69	13.73	13.71
40	42.41	42.32	42.36	1.40	1.42	1.41	53.29	54.77	54.03	6.40	6.66	6.53	14.24	14.38	14.31
60	44.08	44.39	44.23	1.43	1.42	1.43	55.06	55.77	55.41	6.54	6.95	6.75	14.33	14.83	14.58
S.Em.±	0.65	0.72	0.49	0.02	0.02	0.01	0.74	0.80	0.54	0.11	0.11	0.08	0.17	0.18	0.12
CD (P=0.05)	1.96	2.16	1.40	0.06	0.06	0.04	2.23	2.39	1.57	0.33	0.34	0.23	0.50	0.53	0.35
Sulphur levels (S kg ha⁻¹)															
00	39.82	39.89	39.85	1.33	1.33	1.33	46.35	47.20	46.77	5.62	5.59	5.60	13.72	13.93	13.82
20	42.28	42.18	42.23	1.41	1.41	1.41	53.30	53.71	53.51	6.24	6.53	6.39	14.26	14.36	14.31
40	43.72	43.51	43.61	1.42	1.42	1.42	54.60	55.33	54.97	6.51	6.79	6.65	14.28	14.66	14.47
S.Em.±	0.65	0.72	0.49	0.02	0.02	0.01	0.74	0.80	0.54	0.11	0.11	0.08	0.17	0.18	0.12
CD (P=0.05)	1.96	2.16	1.40	0.06	0.06	0.04	2.23	2.39	1.57	0.33	0.34	0.23	0.50	0.53	0.35
Seaweed sap spray															
Control	39.12	40.24	39.68	1.31	1.34	1.33	45.39	48.65	47.02	5.31	5.85	5.58	13.71	13.74	13.72
<i>Kappaphycus</i> sap (10%)	43.87	42.93	43.40	1.44	1.41	1.43	55.26	53.90	54.58	6.57	6.56	6.56	14.68	14.77	14.72
<i>Gracilaria</i> sap (10%)	42.82	42.41	42.62	1.41	1.40	1.40	53.60	53.69	53.65	6.50	6.50	6.50	13.87	14.44	14.15
S.Em.±	0.45	0.52	0.34	0.02	0.01	0.01	0.56	0.50	0.38	0.10	0.11	0.08	0.15	0.16	0.11
CD (P=0.05)	1.28	1.48	0.96	0.05	0.03	0.03	1.62	1.43	1.06	0.30	0.31	0.21	0.43	0.47	0.31

Table 4.12. Effect of phosphorus, sulphur and seaweed sap on yield and harvest index of chickpea

Treatment	Grain yield (kg ha ⁻¹)			Haulm yield (kg ha ⁻¹)			Biological yield (kg ha ⁻¹)			Harvest index (%)		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)												
20	1324	1316	1320	2470	2507	2489	3794	3824	3809	35.32	34.20	34.76
40	1448	1476	1462	2787	2735	2761	4235	4211	4223	34.16	35.08	34.62
60	1496	1524	1510	2878	2826	2852	4374	4350	4362	34.21	35.06	34.63
S.Em.±	25	25	18	49	48	34	70	67	49	0.40	0.45	0.30
CD (P=0.05)	76	75	51	146	143	98	210	201	140	NS	NS	NS
Sulphur levels (S kg ha⁻¹)												
00	1257	1257	1257	2357	2383	2370	3614	3639	3626	35.19	34.35	34.77
20	1477	1501	1489	2835	2791	2813	4312	4292	4302	34.26	34.98	34.62
40	1533	1559	1546	2944	2896	2920	4477	4454	4465	34.25	35.02	34.63
S.Em.±	25	25	18	49	48	34	70	67	49	0.40	0.45	0.30
CD (P=0.05)	76	75	51	146	143	98	210	201	140	NS	NS	NS
Seaweed sap spray												
Control	1301	1304	1303	2447	2465	2456	3748	3769	3759	35.13	34.41	34.77
<i>Kappaphycus</i> sap (10%)	1506	1517	1511	2865	2844	2855	4371	4361	4366	34.46	34.77	34.62
<i>Gracilaria</i> sap (10%)	1461	1495	1478	2823	2759	2791	4284	4254	4269	34.10	35.16	34.63
S.Em.±	23	24	17	43	46	31	62	67	46	0.37	0.37	0.26
CD (P=0.05)	66	70	47	123	131	88	178	192	129	NS	NS	NS

Table 4.16. Effect of phosphorus, sulphur and seaweed sap on grain quality of chickpea

Treatment	Protein content (%)			Methionine (g 16 ⁻¹ g N)			Cysteine (g 16 ⁻¹ g N)			Cystine (g 16 ⁻¹ g N)		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)												
20	21.10	21.20	21.15	1.06	1.08	1.07	1.12	1.11	1.11	1.05	1.05	1.05
40	22.02	21.95	21.99	1.04	1.07	1.06	1.13	1.09	1.11	1.05	1.05	1.05
60	22.06	22.03	22.04	1.08	1.09	1.08	1.14	1.11	1.12	1.02	1.01	1.01
S.Em.±	0.19	0.19	0.14	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.01
CD (P=0.05)	0.58	0.57	0.39	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sulphur levels (S kg ha⁻¹)												
00	21.01	21.12	21.06	0.98	1.01	1.00	1.04	1.04	1.04	0.98	0.98	0.98
20	21.91	22.01	21.96	1.06	1.07	1.07	1.12	1.10	1.11	1.04	1.05	1.05
40	22.26	22.05	22.16	1.14	1.15	1.15	1.24	1.17	1.20	1.10	1.07	1.09
S.Em.±	0.19	0.19	0.14	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.01
CD (P=0.05)	0.58	0.57	0.39	0.06	0.05	0.04	0.06	0.05	0.04	0.05	0.05	0.04
Seaweed sap spray												
Control	21.02	21.22	21.12	1.01	0.99	1.00	1.09	1.03	1.06	0.99	0.99	0.99
<i>Kappaphycus</i> sap(10%)	22.33	21.99	22.16	1.11	1.15	1.13	1.16	1.17	1.16	1.07	1.08	1.08
<i>Gracilaria</i> sap (10%)	21.84	21.97	21.90	1.06	1.10	1.08	1.15	1.10	1.13	1.05	1.04	1.05
S.Em.±	0.16	0.16	0.11	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CD (P=0.05)	0.46	0.45	0.32	0.04	0.03	0.02	0.04	0.03	0.02	0.03	0.03	0.02

Table 4.17. Effect of phosphorus, sulphur and seaweed sap on chlorophyll content of leaves at 60 DAS of chickpea

Treatments	Chlorophyll content (mg g ⁻¹ fresh weight of leaf)		
	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)			
20	1.91	1.92	1.92
40	2.37	2.43	2.40
60	2.47	2.47	2.47
S.Em.±	0.009	0.017	0.010
CD (P=0.05)	0.028	0.050	0.028
Sulphur levels (S kg ha⁻¹)			
00	1.96	1.70	1.83
20	2.36	2.53	2.45
40	2.43	2.59	2.51
S.Em.±	0.009	0.017	0.010
CD (P=0.05)	0.028	0.050	0.028
Seaweed sap spray			
Control	1.81	1.92	1.86
<i>Kappaphycus</i> sap (10%)	2.50	2.59	2.54
<i>Gracilaria</i> sap (10%)	2.45	2.31	2.38
S.Em.±	0.005	0.015	0.008
CD (P=0.05)	0.015	0.044	0.023

Table 4.18. Effect of phosphorus, sulphur and seaweed sap on nitrogen content in chickpea

Treatment	N content (%)								
	Leaves at 60 DAS			Grain			Haulm		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)									
20	2.994	3.220	3.107	3.376	3.392	3.384	0.720	0.736	0.728
40	3.419	3.479	3.449	3.524	3.512	3.518	0.819	0.800	0.809
60	3.455	3.499	3.477	3.529	3.525	3.527	0.822	0.801	0.811
S.Em.±	0.014	0.014	0.010	0.031	0.030	0.022	0.007	0.006	0.005
CD (P=0.05)	0.041	0.043	0.028	0.092	0.091	0.062	0.022	0.018	0.014
Sulphur levels (S kg ha⁻¹)									
00	3.044	3.261	3.152	3.362	3.379	3.370	0.756	0.737	0.747
20	3.390	3.465	3.427	3.505	3.521	3.513	0.800	0.799	0.800
40	3.433	3.473	3.453	3.562	3.528	3.545	0.803	0.801	0.802
S.Em.±	0.014	0.014	0.010	0.031	0.030	0.022	0.007	0.006	0.005
CD (P=0.05)	0.041	0.043	0.028	0.092	0.091	0.062	0.022	0.018	0.014
Seaweed sap spray									
Control	3.023	3.162	3.093	3.363	3.395	3.379	0.735	0.726	0.730
<i>Kappaphycus</i> sap (10%)	3.424	3.614	3.519	3.572	3.519	3.545	0.816	0.812	0.814
<i>Gracilaria</i> sap (10%)	3.420	3.421	3.421	3.494	3.515	3.505	0.809	0.800	0.804
S.Em.±	0.003	0.007	0.004	0.025	0.025	0.018	0.007	0.004	0.004
CD (P=0.05)	0.009	0.019	0.010	0.073	0.073	0.051	0.020	0.011	0.011

Table 4.19. Effect of phosphorus, sulphur and seaweed sap on phosphorus content in chickpea

Treatment	P content (%)								
	Leaves at 60 DAS			Grain			Haulm		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)									
20	0.440	0.437	0.439	0.340	0.325	0.333	0.213	0.212	0.213
40	0.450	0.448	0.449	0.353	0.340	0.347	0.221	0.225	0.223
60	0.458	0.466	0.462	0.365	0.348	0.357	0.227	0.231	0.229
S.Em.±	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.001	0.001
CD (P=0.05)	0.006	0.007	0.005	0.008	0.006	0.005	0.005	0.004	0.003
Sulphur levels (S kg ha⁻¹)									
00	0.441	0.431	0.436	0.337	0.330	0.334	0.214	0.214	0.214
20	0.453	0.460	0.456	0.351	0.341	0.346	0.223	0.226	0.224
40	0.454	0.461	0.458	0.370	0.343	0.356	0.224	0.228	0.226
S.Em.±	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.001	0.001
CD (P=0.05)	0.006	0.007	0.005	0.008	0.006	0.005	0.005	0.004	0.003
Seaweed sap spray									
Control	0.438	0.439	0.438	0.332	0.324	0.328	0.209	0.211	0.210
<i>Kappaphycus</i> sap (10%)	0.458	0.457	0.457	0.364	0.345	0.355	0.227	0.229	0.228
<i>Gracilaria</i> sap (10%)	0.453	0.455	0.454	0.362	0.344	0.353	0.225	0.229	0.227
S.Em.±	0.002	0.002	0.001	0.002	0.001	0.001	0.001	0.001	0.001
CD (P=0.05)	0.006	0.006	0.004	0.006	0.004	0.004	0.004	0.003	0.002

Table 4.20. Effect of phosphorus, sulphur and seaweed sap on potassium content in chickpea

Treatment	K content (%)								
	Leaves at 60 DAS			Grain			Haulm		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)									
20	2.301	2.312	2.307	0.645	0.620	0.632	1.883	1.815	1.849
40	2.450	2.443	2.447	0.654	0.671	0.663	1.937	1.947	1.942
60	2.475	2.468	2.472	0.700	0.694	0.697	1.957	1.973	1.965
S.Em.±	0.013	0.022	0.013	0.004	0.008	0.004	0.010	0.016	0.010
CD (P=0.05)	0.039	0.066	0.037	0.012	0.023	0.012	0.031	0.049	0.028
Sulphur levels (S kg ha⁻¹)									
00	2.253	2.263	2.258	0.599	0.599	0.599	1.772	1.712	1.742
20	2.481	2.469	2.475	0.699	0.687	0.693	1.998	1.993	1.996
40	2.492	2.491	2.492	0.701	0.698	0.700	2.007	2.029	2.018
S.Em.±	0.013	0.022	0.013	0.004	0.008	0.004	0.010	0.016	0.010
CD (P=0.05)	0.039	0.066	0.037	0.012	0.023	0.012	0.031	0.049	0.028
Seaweed sap spray									
Control	2.296	2.297	2.297	0.611	0.613	0.612	1.791	1.780	1.786
<i>Kappaphycus</i> sap (10%)	2.467	2.465	2.466	0.695	0.687	0.691	2.004	1.983	1.993
<i>Gracilaria</i> sap (10%)	2.463	2.461	2.462	0.693	0.684	0.689	1.982	1.971	1.976
S.Em.±	0.009	0.020	0.011	0.003	0.006	0.003	0.008	0.012	0.007
CD (P=0.05)	0.025	0.058	0.031	0.009	0.018	0.010	0.022	0.035	0.021

Table 4.21. Effect of phosphorus, sulphur and seaweed sap on sulphur content in chickpea

Treatment	S content (%)								
	Leaves at 60 DAS			Grain			Haulm		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)									
20	0.198	0.199	0.198	0.178	0.187	0.182	0.070	0.071	0.070
40	0.211	0.209	0.210	0.197	0.200	0.199	0.074	0.074	0.074
60	0.212	0.211	0.212	0.201	0.202	0.202	0.076	0.075	0.075
S.Em.±	0.002	0.001	0.001	0.002	0.002	0.001	0.0007	0.0006	0.0005
CD (P=0.05)	0.005	0.004	0.003	0.005	0.005	0.003	0.0020	0.0019	0.0013
Sulphur levels (S kg ha⁻¹)									
00	0.193	0.197	0.195	0.172	0.184	0.178	0.069	0.069	0.069
20	0.213	0.209	0.211	0.199	0.198	0.199	0.074	0.074	0.074
40	0.215	0.213	0.214	0.206	0.206	0.206	0.077	0.078	0.077
S.Em.±	0.002	0.001	0.001	0.002	0.002	0.001	0.0007	0.0006	0.0005
CD (P=0.05)	0.005	0.004	0.003	0.005	0.005	0.003	0.0020	0.0019	0.0013
Seaweed sap spray									
Control	0.197	0.198	0.197	0.182	0.186	0.184	0.069	0.071	0.070
<i>Kappaphycus</i> sap (10%)	0.213	0.211	0.212	0.198	0.202	0.200	0.076	0.075	0.075
<i>Gracilaria</i> sap (10%)	0.211	0.210	0.211	0.197	0.200	0.198	0.075	0.075	0.075
S.Em.±	0.001	0.001	0.001	0.001	0.001	0.001	0.0004	0.0004	0.0003
CD (P=0.05)	0.004	0.002	0.002	0.003	0.003	0.002	0.0010	0.0010	0.0008

Table 4.22. Effect of phosphorus, sulphur and seaweed sap on nitrogen uptake by chickpea

Treatment	N uptake (kg ha ⁻¹)								
	Grain			Haulm			Total		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)									
20	45.12	45.29	45.20	18.34	18.67	18.50	63.46	63.95	63.71
40	51.13	51.92	51.53	22.88	21.99	22.43	74.01	73.91	73.96
60	52.84	53.71	53.27	23.66	22.72	23.19	76.49	76.43	76.46
S.Em.±	0.97	0.90	0.66	0.39	0.38	0.27	1.29	1.05	0.83
CD (P=0.05)	2.91	2.71	1.91	1.16	1.13	0.78	3.86	3.15	2.40
Sulphur levels (S kg ha⁻¹)									
00	42.61	42.98	42.80	18.41	17.77	18.09	61.02	60.76	60.89
20	51.95	52.81	52.38	22.77	22.34	22.56	74.72	75.15	74.94
40	54.52	55.13	54.83	23.69	23.26	23.47	78.21	78.39	78.30
S.Em.±	0.97	0.90	0.66	0.39	0.38	0.27	1.29	1.05	0.83
CD (P=0.05)	2.91	2.71	1.91	1.16	1.13	0.78	3.86	3.15	2.40
Seaweed sap spray									
Control	43.97	44.63	44.30	18.47	18.04	18.25	62.44	62.66	62.55
<i>Kappaphycus</i> sap (10%)	54.04	53.77	53.91	23.53	23.13	23.33	77.57	76.91	77.24
<i>Gracilaria</i> sap (10%)	51.07	52.52	51.79	22.87	22.21	22.54	73.94	74.72	74.33
S.Em.±	0.87	1.03	0.67	0.37	0.39	0.27	1.13	1.35	0.88
CD (P=0.05)	2.51	2.95	1.90	1.06	1.12	0.76	3.23	3.88	2.48

Table 4.26. Effect of phosphorus, sulphur and seaweed sap on phosphorus uptake by chickpea

Treatment	P uptake (kg ha ⁻¹)								
	Grain			Haulm			Total		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)									
20	4.52	4.38	4.45	5.24	5.32	5.28	9.76	9.70	9.73
40	5.18	5.02	5.10	6.19	6.17	6.18	11.36	11.19	11.28
60	5.47	5.31	5.39	6.61	6.56	6.59	12.08	11.87	11.97
S.Em.±	0.11	0.08	0.07	0.10	0.11	0.07	0.18	0.17	0.12
CD (P=0.05)	0.34	0.25	0.20	0.29	0.32	0.21	0.54	0.51	0.36
Sulphur levels (S kg ha⁻¹)									
00	4.28	4.19	4.24	5.11	5.12	5.11	9.39	9.31	9.35
20	5.21	5.17	5.19	6.35	6.35	6.35	11.57	11.52	11.54
40	5.67	5.34	5.51	6.57	6.59	6.58	12.24	11.94	12.09
S.Em.±	0.11	0.08	0.07	0.10	0.11	0.07	0.18	0.17	0.12
CD (P=0.05)	0.34	0.25	0.20	0.29	0.32	0.21	0.54	0.51	0.36
Seaweed sap spray									
Control	4.38	4.21	4.30	5.19	5.21	5.20	9.57	9.43	9.50
<i>Kappaphycus</i> sap (10%)	5.49	5.28	5.39	6.50	6.52	6.51	12.00	11.80	11.90
<i>Gracilaria</i> sap (10%)	5.29	5.22	5.25	6.34	6.32	6.33	11.63	11.54	11.58
S.Em.±	0.09	0.09	0.06	0.11	0.12	0.08	0.18	0.19	0.13
CD (P=0.05)	0.25	0.24	0.17	0.31	0.33	0.22	0.50	0.54	0.36

Table 4.30. Effect of phosphorus, sulphur and seaweed sap on potassium uptake by chickpea

Treatment	K uptake (kg ha ⁻¹)								
	Grain			Haulm			Total		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)									
20	8.64	8.25	8.45	47.08	46.36	46.72	55.72	54.62	55.17
40	9.58	10.03	9.81	54.48	53.93	54.21	64.06	63.97	64.01
60	10.55	10.63	10.59	56.55	55.97	56.26	67.09	66.60	66.85
S.Em.±	0.18	0.15	0.12	1.01	0.91	0.68	1.15	1.03	0.77
CD (P=0.05)	0.54	0.44	0.33	3.03	2.74	1.96	3.43	3.09	2.22
Sulphur levels (S kg ha⁻¹)									
00	7.63	7.63	7.63	42.29	41.66	41.97	49.92	49.29	49.60
20	10.35	10.38	10.36	56.61	55.78	56.20	66.95	66.16	66.56
40	10.79	10.91	10.85	59.21	58.82	59.01	69.99	69.73	69.86
S.Em.±	0.18	0.15	0.12	1.01	0.91	0.68	1.15	1.03	0.77
CD (P=0.05)	0.54	0.44	0.33	3.03	2.74	1.96	3.43	3.09	2.22
Seaweed sap spray									
Control	8.05	8.10	8.08	44.59	44.77	44.68	52.64	52.87	52.75
<i>Kappaphycus</i> sap (10%)	10.55	10.54	10.54	57.67	56.96	57.32	68.22	67.50	67.86
<i>Gracilaria</i> sap (10%)	10.16	10.28	10.22	55.85	54.54	55.19	66.01	64.81	65.41
S.Em.±	0.15	0.17	0.11	0.80	0.92	0.61	0.91	1.05	0.70
CD (P=0.05)	0.44	0.49	0.32	2.28	2.65	1.72	2.61	3.02	1.96

Table 4.34. Effect of phosphorus, sulphur and seaweed sap on sulphur uptake by chickpea

Treatment	S uptake (kg ha ⁻¹)								
	Grain			Haulm			Total		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)									
20	2.38	2.47	2.42	1.72	1.79	1.76	4.10	4.25	4.18
40	2.89	2.98	2.93	2.09	2.05	2.07	4.98	5.03	5.01
60	3.03	3.09	3.06	2.19	2.14	2.16	5.22	5.23	5.22
S.Em.±	0.06	0.05	0.04	0.03	0.04	0.02	0.09	0.07	0.06
CD (P=0.05)	0.18	0.14	0.11	0.10	0.11	0.07	0.26	0.22	0.17
Sulphur levels (S kg ha⁻¹)									
00	2.18	2.34	2.26	1.63	1.66	1.64	3.81	4.00	3.90
20	2.95	2.99	2.97	2.11	2.06	2.08	5.06	5.05	5.05
40	3.17	3.21	3.19	2.26	2.26	2.26	5.43	5.47	5.45
S.Em.±	0.06	0.05	0.04	0.03	0.04	0.02	0.09	0.07	0.06
CD (P=0.05)	0.18	0.14	0.11	0.10	0.11	0.07	0.26	0.22	0.17
Seaweed sap spray									
Control	2.39	2.45	2.42	1.71	1.75	1.73	4.10	4.20	4.15
<i>Kappaphycus</i> sap (10%)	3.02	3.08	3.05	2.18	2.15	2.17	5.20	5.23	5.21
<i>Gracilaria</i> sap (10%)	2.89	3.01	2.95	2.12	2.07	2.09	5.01	5.08	5.04
S.Em.±	0.04	0.05	0.03	0.03	0.04	0.02	0.07	0.08	0.05
CD (P=0.05)	0.13	0.13	0.09	0.09	0.10	0.07	0.20	0.22	0.15

Table 4.38. Effect of phosphorus, sulphur and seaweed sap on available nutrient status of soil at harvest of chickpea

[illegible]

Table 4.39. Effect of Phosphorus, sulphur and seaweed sap on net returns and B C ratio of chickpea

Treatment	Net returns (₹/ha)			B C ratio		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Phosphorus levels (P₂O₅ kg ha⁻¹)						
20	25989	26665	26327	1.24	1.22	1.23
40	29638	31462	30550	1.35	1.39	1.37
60	30296	32161	31228	1.32	1.36	1.34
S.Em.±	885	891	628	0.04	0.04	0.03
CD (P=0.05)	2652	2671	1808	NS	0.12	0.08
Sulphur levels (S kg ha⁻¹)						
00	22824	23617	23220	1.04	1.04	1.04
20	30696	32425	31561	1.41	1.44	1.42
40	32403	34246	33324	1.47	1.50	1.49
S.Em.±	885	891	628	0.04	0.04	0.03
CD (P=0.05)	2652	2671	1808	0.12	0.12	0.08
Seaweed sap spray						
Control	26143	27097	26620	1.30	1.30	1.30
<i>Kappaphycus</i> sap (10%)	30652	32041	31346	1.34	1.36	1.35
<i>Gracilaria</i> sap (10%)	29129	31150	30139	1.28	1.32	1.30
S.Em.±	801	879	595	0.04	0.04	0.03
CD (P=0.05)	2297	2522	1677	NS	NS	NS

Table 5.1. Correlation coefficients and regression equation ($y = a + bx$) between various crop parameters (based on pooled mean of two years)

S.No	Dependent variable (y)	Independent variable (x)	Coefficient of correlation 'r'	Regression equation
1	Grain yield (kg ha ⁻¹)	Primary branches at 60 DAS	0.589**	828.617 + 169.191x
2	Grain yield (kg ha ⁻¹)	Pods plant ⁻¹	0.452*	630.164 + 19.105x
3	Grain yield (kg ha ⁻¹)	Grains pod ⁻¹	0.463*	382.154 + 756.535x
4	Grain yield (kg ha ⁻¹)	Grains plant ⁻¹	0.533**	805.109 + 12.087x
5	Grain yield (kg ha ⁻¹)	Grain yield (g plant ⁻¹)	0.569**	787.889 + 103.438x
6	Grain yield (kg ha ⁻¹)	100 grain weight	0.725**	-1406.873 + 199.82x
7	Grain yield (kg ha ⁻¹)	N uptake by grain	0.953**	365.940 + 21.293x
8	Grain yield (kg ha ⁻¹)	P uptake by grain	0.913**	555.877 + 175.721x
9	Grain yield (kg ha ⁻¹)	K uptake by grain	0.967**	587.849 + 87.665x
10	Grain yield (kg ha ⁻¹)	S uptake by grain	0.959**	546.529 + 315.064x
11	Haulm yield (kg ha ⁻¹)	Plant height at 60 DAS	0.780**	-288.097 + 80.956 x
12	Haulm yield (kg ha ⁻¹)	Primary branches at 60 DAS	0.590**	1547.588 + 324.083x
13	Haulm yield (kg ha ⁻¹)	N uptake by haulm	0.983**	848.997 + 86.627x
14	Haulm yield (kg ha ⁻¹)	P uptake by haulm	0.719**	1583.781 + 185.664x
15	Haulm yield (kg ha ⁻¹)	K uptake by haulm	0.974**	984.591 + 32.753x
16	Haulm yield (kg ha ⁻¹)	S uptake by haulm	0.941**	988.951 + 857.429x
17	Biological yield (kg ha ⁻¹)	Plant height at 60 DAS	0.781**	-425.487 + 123.427x
18	Biological yield (kg ha ⁻¹)	Plant height at harvest	0.442*	888.571 + 58.654x
19	Biological yield (kg ha ⁻¹)	Grain yield	1.000**	-32.664 + 2.911x
20	Biological yield (kg ha ⁻¹)	Haulm yield	1.000**	17.529 + 1.523x
21	Biological yield (kg ha ⁻¹)	Total N uptake	0.978**	1023.455 + 43.542x
22	Biological yield (kg ha ⁻¹)	Total P uptake	0.902**	1544.484 + 235.300x
23	Biological yield (kg ha ⁻¹)	Total K uptake	0.976**	1524.360 + 42.041x
24	Biological yield (kg ha ⁻¹)	Total S uptake	0.956**	1519.999 + 543.750x
25	N uptake by grain	Protein content in grain (%)	0.793**	-52.954 + 4.739x
26	Grain yield (kg ha ⁻¹)	Chlorophyll content in leaves (60 DAS)	0.851**	710.108 + 318.584x

** Significant at 1 % levels of significance

* Significant at 5 % levels of significance