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Impact of Time of Sowing, Spacing and Seed Rate on Potential Seed Production and Fodder Quality of Cowpea /Vigna Unguiculata (L.) Walp

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Abstract: *To study the Impact Of Time Of Sowing, Spacing And Seed Rate On Potential Seed Production And Fodder Quality Of Cowpea, the field trial was conducted in kharif 2011 on medium deep black clay soil under rainfed condition at Directorate of Animal Husb. & Vety. Govt. of Arunachal Pradesh, Nirjuli. The treatments comprised combination of three times of sowing (June second fortnight, July first fortnight and July second fortnight), two-row spacing (30 cm and 45 cm) and three seed rates (20, 25 and 30 kg ha^{-1}). With three replications, in split-split plot design, the trial was laid out. Compared to July first fortnight and July second fortnight sowing, significantly higher seed yield, haulm yield and harvest index (923 kg ha^{-1}, 4440 kg ha^{-1} and 0.30 respectively) were recorded in cowpea sown in June second fortnight. Significantly, higher growth parameters at harvest viz., leaf area index (2.19), fresh weight (370.22 g plant^{-1}), total dry matter (63.32 g plant^{-1}) and dry matter accumulation in leaves, stem and reproductive parts were also recorded in June second fortnight sowing. Time of sowing did not significantly influence the proximate quality parameters of seed and haulm and the seed quality parameters. Compared to 45 cm, significantly higher growth and yield attributes, seed yield (741 kg ha^{-1}) and haulm yield (4196 kg ha^{-1}) was recorded in row spacing of 30 cm. The proximate quality of seed and haulm and also seed quality were not influenced significantly by the row spacing. Growth, yield, proximate quality of seed and haulm and seed quality of cowpea were not significantly influenced by the Seed rate. in fodder cowpea with June second fortnight sowing with 30 cm row spacing at 30 kg ha^{-1} seed rate for seed yield (1054 kg ha^{-1}) and haulm yield (4968 kg ha^{-1}), significantly higher interaction was recorded.*

Key Words: *fodder; yield; growth parameters, quality parameters.*

I. Introduction

India is house to 15% (540 million) world cattle population (Singh, 2003) and 16% of human population to be sustained and progressed on 2% of total geographical areas.

Throughout the last decade, the dairy industry in the country has exposed impressive growth and now India is the largest producer of milk. Singh, (2003) reported that current availability of green/dry fodder is estimated at 390 and 443 million tones, respectively. Owing to feed/fodder shortages which lean to be even more severe during natural calamities, efforts to boost livestock productivity are constrained. In view of the precedence for food grains, oilseeds and pulses, there is a little scale for escalating the area under fodder cultivation. Therefore, augment in the productivity of available forage resources per unit land area and time is necessitated.

Cowpea [Vigna unguiculata (L). Walp] is one of the most important legume forage crops. According to USDA food database, it has the highest percentage of calories from protein among vegetarian foods. In different countries, it is esteemed for its varied uses as food, green manure, nitrogen fixing (through root nodules) etc. As a forage crop, it is drought/shade tolerant, quick growing, high yielding, with substantially rich biomass production, grows well with associated crops. For fodder production, it is mainly grown as mixed/inter crop with cereals. Nevertheless, in forage legumes, quality seed production and availability is lacking.

Cowpea in Arunachal Pradesh is one of the important kharif forage legumes. The cultivation package accessible for its seed production is nearly lacking. Keeping this locale in view, the present research was intended with the following objectives.

1. To determine the optimum time of sowing, spacing and seed rate for higher seed production of fodder cowpea.
2. To study the quality parameters of seed and haulm.

II. Material And Methods

The field experiment was conducted at Directorate of Animal Husb. & Vety. Govt. of Arunachal Pradesh, Nirjuli,under rainfed conditions during kharif 2011.

The experimental soil site was medium deep black clay. The soil had medium (285 kg ha^{-1}) available nitrogen, available phosphorus (21.68 kg ha^{-1}) and available potassium (208.53 kg ha^{-1}).

Experimental Details

Treatments: 18 treatment combinations consisting of three times of sowing, two spacing and three seed rates were undertaken. The details of treatment are: A) Main plot-sowing time : June second fortnight; July first fortnight; July second fortnight B) Sub plot - Row spacing : 30 cm; 45 cm C) Sub-sub plot - seed rate : 20 kg ha^{-1}; 25 kg ha^{-1}; 30 kg ha^{-1}

With three replications, the experiment was laid out in split - split plot design. The plot size was of Gross: 4.5 m x 4.0 m & Net: 3.6 m x 3.4 m.

During 1988, Genotype 'Swad' (DFC-1) was released. With profuse branching, broad leaves and leafier, Plant grows to a height of 85 cm, bushy & compact. With maturity range of 85 days from seed to seed, it falls under medium maturity group. Seeds are generally dark brown and bold.

The statistics obtained by various observations were subjected to Fisher's method of analysis of variance and analysis of data as given by Gomez and Gomez (1984).

III. Results & Discussion

The results obtained from the field experiment conducted at Directorate of Animal Husb. & Vety. Govt. of Arunachal Pradesh, Nirjuli, during kharif 2011 to study the "impact of time of sowing, spacing and seed rate on potential seed production and fodder quality of cowpea" are discussed.

Effect of Time of Sowing Growth and yield

Significantly, delayed sowing reduced the yield of seed, haulm and haulm dry matter.

Compared to D_2 viz., July first fortnight sowing (673 kg ha^{-1}) and D_3 viz., July second fortnight sowing (517 kg ha^{-}), June second fortnight (D_1) sowing produced significantly higher seed yield (923 kg ha^{-1}).

Though, D_2 was significant over D_3. D_1 produced 25 and 41 per cent higher grain yield compared to D_2 and D_3, respectively.

Compared to D_2 and D_3, the haulm yield and harvest index were also significantly higher in D_1 (4440 kg ha^{-1} and 0.3, respectively). On the other hand, D_2 was significant over D_3.

Ravinder and Singh (1998) in mungbean, & Yadav (2003) in cowpea, also reported similar results of higher seed yield in early sowing compared to late sowing.

Mainly due to significantly higher growth and yield components, there was increase in seed yield, haulm yield and harvest index with early sowing in June second fortnight (D_1), compared to late sowing in D_2 and D_3.

Significantly, June second fortnight sowing recorded higher plant height (153.8 cm, Table 3), number of leaves (36.4 $plant^{-1}$, Table 4), number of branches (5.0 $plant^{-1}$, Table 5), leaf area (1048.98 cm^2 $plant^{-1}$, Table 6), LAI (2.19, Table 7), fresh weight (370.22 g $plant^{-1}$, Table 8), total dry matter accumulation (63.32 g $plant^{-1}$, Table 9), number of pods (11.0 $plant^{-1}$, Table 10), number of seeds (11.0 pod^{-1}, Table 10) and 1000 seed weight (100.0 g, Table 10).

Table 1. Seed yield per plant, seed and seed dry matter yield per ha as influenced by time of sowing, row spacing and seed rate

Time of sowing	Seed rate kg ha^{-1}	Seed yield (g plant-1) Row spacing			Seed yield (kg ha-1)			Seed dry matter yield (kg ha-1)		
		S1 (30 cm)	S2 (45 cm)	Mean	S1 (30 cm)	S2 (45 cm)	Mean	S1 (30 cm)	S2 (45 cm)	Mean
D_1- Second fortnight of June	P1-20	14.33	13.67	14	933	805	869	845	729	787
	P2-25	12.28	12.71	12.5	1014	911	962	918	825	872
	P3-30	16.6	11.43	14	1054	823	938	954	745	850
	Mean	14.4	12.6	13.5	1000	847	923	906	767	836
D_2- First fortnight of July	P1-20	8.46	7.3	7.88	670	573	621	607	519	563
	P2-25	7.17	8.13	7.65	679	753	716	615	682	649
	P3-30	7.19	7.4	7.29	754	610	682	683	552	618
	Mean	7.61	7.61	7.61	701	645	673	635	584	610
D_3- Second fortnight of July	P1-20	6.05	5.3	5.67	494	553	523	447	500	474
	P2-25	5.63	4.66	5.14	584	493	539	529	447	488
	P3-30	5.2	4.51	4.85	489	492	490	442	446	444
	Mean	5.62	4.82	5.22	522	513	517	473	464	469

	P1-20	9.61	8.75	9.18	699	644	671	633	583	608
	P2-25	8.36	8.5	8.43	759	719	739	687	651	669
	P3-30	9.66	7.78	8.72	765	642	704	693	581	637
	Mean	9.24	8.34	8.78	741	668	705	671	605	638

Table 2. Haulm, haulm dry matter yield and harvest index of cowpea as influenced by time of sowing, spacing and seed rate

Time of sowing	Seed rate kg ha^{-1}	Haulm yield (kg ha^{-1})			Haulm drymatter yield (kg ha^{-1})			Harvest index		
		Row spacing								
		S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	Mean
D_1- Second fortnight of June	P_1-20	4569	4244	4416	878	906	892	0.3	0.29	0.29
	P_2-25	4838	4340	4589	852	708	780	0.31	0.31	0.31
	P_3-30	4968	3661	4314	897	541	719	0.31	0.32	0.31
	Mean	4791	4088	4440	876	718	797	0.3	0.3	0.3
D_2- First fortnight of July	P_1-20	4004	4286	4145	688	806	747	0.27	0.23	0.25
	P_2-25	4070	4082	4076	708	712	710	0.26	0.28	0.27
	P_3-30	4260	3455	3837	707	598	652	0.27	0.28	0.27
	Mean	4111	3941	4026	701	705	703	0.27	0.26	0.26
D_3- Second fortnight of July	P_1-20	3757	3831	3794	690	651	671	0.23	0.24	0.24
	P_2-25	3684	3633	3658	648	642	645	0.25	0.23	0.24
	P_3-30	3614	3676	3645	603	603	603	0.23	0.23	0.23
	Mean	3685	3713	3699	647	632	640	0.24	0.23	0.24
	P_1-20	4110	4127	4118	752	788	770	0.26	0.25	0.26
	P_2-25	4197	4018	4108	736	687	712	0.27	0.27	0.27
	P_3-30	4280	3597	3939	735	581	658	0.27	0.27	0.27
	Mean	4196	3914	4055	741	685	713	0.27	0.27	0.27

Table 3. Plant height (cm) of cowpea as influenced by time of sowing, spacing and seed rate

Time of sowing	Seed rate kg ha^{-1}	30 DAS			60 DAS			At harvest		
		Row spacing								
		S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	M ean
D_1- Second fortnight of June	P_1-20	20.1	18.7	19.4	56.4	54.4	55.4	156.8	150.8	153.8
	P_2-25	20.7	19.2	19.9	56.8	52.7	54.8	166.7	148.7	157.7
	P_3-30	21.2	20.6	20.9	51.9	42.5	47.2	154.4	145.4	149.9
	Mean	20.6	19.5	20.1	55.0	49.9	52.5	159.1	148.3	153.8
D_2- First fortnight of July	P_1-20	13.3	14.1	13.7	36.2	34.6	35.4	140.6	134.7	137.7
	P_2-25	14.9	12.5	13.7	37.5	36.5	37.0	147.1	134.7	140.9
	P_3-30	14.5	14.2	14.3	35.0	32.7	33.8	143.3	133.3	138.3
	Mean	14.2	13.6	13.9	36.2	34.6	35.4	143.7	134.3	139.0
D_3- Second fortnight of July	P_1-20	12.6	12.6	12.6	37.1	36.4	36.8	139.7	138.1	138.9
	P_2-25	12.5	12.1	12.3	37.1	31.7	33.4	138.1	135.4	136.7
	P_3-30	11.0	12.2	11.6	35.2	34.7	34.9	138.1	133.1	135.6
	Mean	12.0	12.3	12.2	35.8	34.3	35.0	138.6	135.5	137.1
	P_1-20	15.3	15.1	15.2	43.2	41.8	42.5	145.7	141.2	143.4
	P_2-25	16.0	14.6	15.3	43.1	40.3	41.7	150.6	139.6	145.1
	P_3-30	15.5	15.6	15.6	40.7	36.6	38.6	145.3	137.3	141.3
	Mean	15.6	15.1	15.4	42.3	39.6	41.0	147.2	139.3	143.3

Table 4. Number of green trifoliate leaves (plant^{-1}) of cowpea as influenced by time of sowing, spacing and seed rate

Time of sowing	Seed rate kg ha^{-1}	30 DAS 60 DAS At harvest								
		Row spacing								
		S1 (30 cm)	S2 (45 cm)	Mean	S1 (30 cm)	S2 (45 cm)	Mean	S1 (30 cm)	S2 (45 cm)	Mean
D_1- Second fortnight of June	P_1-20	3.8	3.4	3.6	28.16	25.73	26.95	38.50	34.43	36.46
	P_2-25	6.4	4.5	5.5	29.00	25.06	27.03	40.43	35.13	37.78
	P_3-30	4.9	6.6	5.7	27.00	24.00	25.50	36.33	33.80	35.06
	Mean	5.0	4.8	4.9	28.05	24.93	26.49	38.42	34.45	36.43
D_2- First fortnight of July	P_1-20	3.0	4.3	3.6	25.53	19.83	22.68	29.43	28.76	29.10
	P_2-25	3.5	3.6	3.5	23.43	20.80	22.11	29.10	29.10	29.10
	P_3-30	3.8	3.5	3.6	22.76	19.53	21.15	28.76	28.76	28.76
	Mean	3.4	3.8	3.6	23.91	20.05	21.98	29.10	28.87	28.98
D_3- Second fortnight of July	P_1-20	3.6	3.2	3.4	22.23	22.00	22.11	29.76	28.43	29.10
	P_2-25	3.6	3.3	3.4	22.73	20.06	21.40	28.76	28.10	28.43
	P_3-30	2.9	2.3	2.6	22.80	19.80	21.30	30.76	27.10	28.93
	Mean	3.4	2.9	3.1	22.58	20.62	21.60	29.76	27.87	28.82
	P_1-20	3.5	3.6	4.0	25.31	22.52	23.91	32.56	30.54	31.55
	P_2-25	4.5	3.8	4.1	25.05	21.97	23.51	32.76	30.77	31.77
	P_3-30	3.8	4.1	4.0	24.18	21.11	22.65	31.95	29.88	30.92
	Mean	3.9	3.8	3.9	24.85	21.87	23.36	32.43	30.40	31.41

Table 5. Number of branches (plant^{-1}) of cowpea as influenced by time of sowing, spacing and seed rate

Time of sowing	Seed rate kg ha^{-1}	60 DAS			At harvest		
		Row spacing					
		S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	Mean
D_1- Second fortnight of June	P_1-20	4.3	3.9	4.1	5.9	4.9	5.4
	P_2-25	4.9	3.7	4.3	6.4	3.7	5.1
	P_3-30	4.2	4.3	4.2	5.3	4.1	4.7
	Mean	4.5	4	4.2	5.8	4.2	5
D_2- First fortnight of July	P_1-20	3.1	1.5	2.3	4.3	2.1	3.2
	P_2-25	2.2	1.9	2.1	3.1	2.9	3
	P_3-30	1.9	2.2	2	2.8	2.6	2.7
	Mean	2.4	1.9	2.1	3.4	2.5	3
D_3- Second fortnight of July	P_1-20	2.4	1.8	2.1	2.9	2.7	2.8
	P_2-25	1.8	1.7	1.8	2.1	3.4	2.8
	P_3-30	2	1.5	1.8	3.2	2.9	3
	Mean	2.1	1.7	1.9	2.7	3	2.9
	P_1-20	3.3	2.4	2.8	4.4	3.2	3.8
	P_2-25	3	2.4	2.7	3.9	3.3	3.6
	P_3-30	2.7	2.7	2.7	3.8	3.2	3.5
	Mean	3.0	2.5	2.7	4.0	3.2	3.6

Table 6. Leaf area (cm^2 plant^{-1}) of cowpea as influenced by time of sowing, spacing and seed rate

Time of sowing	Seed rate kg ha^{-1}	30 DAS			60 DAS			At harvest		
		Row spacing								
		S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	Mean
D_1- Second fortnight of June	P_1-20	236.03	239.9	237.96	1019.43	865.2	942.31	1243.74	1102.91	1173.32
	P_2-25	266.93	270.7	268.81	990.1	905.73	947.91	1079.62	913.99	986.8
	P_3-30	241.5	280.73	261.11	1038	879.23	958.61	1012.67	940.94	976.8
	Mean	248.15	263.77	255.96	1015.84	883.38	949.61	1112.01	985.95	1048.98
D_2- First fortnight of July	P_1-20	210.6	248.76	229.68	952.53	607.33	779.93	1014.82	696.61	855.72
	P_2-25	205.53	225.93	215.73	609.12	741.56	675.34	998.25	824.81	911.53
	P_3-30	219.46	201.23	210.35	730.83	659.8	695.31	987.7	713.24	850.47
	Mean	211.86	225.31	218.58	764.16	669.56	716.86	1000.26	744.89	872.57
D_3- Second fortnight of July	P_1-20	213.8	214.63	214.21	853.7	647.83	750.76	912.04	775.72	843.88
	P_2-25	226.06	239.33	232.7	796.56	544.73	670.65	853.31	784	818.66
	P_3-30	227.3	194.66	210.98	728.63	522.86	625.75	932.12	601.59	766.85
	Mean	222.38	216.21	219.3	792.96	571.81	682.38	899.16	720.44	809.8
	P_1-20	220.14	234.43	227.28	941.88	706.78	824.33	1056.87	858.41	957.64
	P_2-25	232.84	245.32	239.08	798.59	730.67	764.63	977.06	840.93	909
	P_3-30	229.42	225.54	227.48	832.48	687.3	759.89	977.49	751.92	864.71
	Mean	227.47	235.10	231.28	857.65	708.25	782.95	1003.81	817.09	909.78

Table 7. Leaf area index (LAI) of cowpea as influenced by time of sowing, spacing and seed rate

Time of sowing	Seed rate kg ha-1	30 DAS			60 DAS			At harvest		
		Row spacing								
		S1 (30 cm)	S2 (45 cm)	Mean	S1 (30 cm)	S2 (45 cm)	Mean	S1 (30 cm)	S2 (45 cm)	Mean
D1- Second fortnight of June	P_1-20	0.53	0.54	0.53	1.89	1.62	1.75	2.11	1.88	1.99
	P_2-25	0.71	0.71	0.71	2.25	2.07	2.16	2.26	1.93	2.09
	P_3-30	0.77	0.88	0.83	2.83	2.41	2.62	2.57	2.39	2.48
	Mean	0.67	0.71	0.69	2.32	2.03	2.18	2.31	2.06	2.19
D2- First fortnight of July	P_1-20	0.48	0.55	0.52	1.77	1.16	1.47	1.74	1.22	1.48
	P_2-25	0.57	0.62	0.59	1.43	1.72	1.57	2.1	1.75	1.92
	P_3-30	0.71	0.66	0.69	2.02	1.83	1.93	2.51	1.84	2.18
	Mean	0.59	0.61	0.6	1.74	1.57	1.65	2.11	1.6	1.86
D3- Second fortnight of July	P_1-20	0.49	0.49	0.49	1.6	1.24	1.42	1.57	1.35	1.46
	P_2-25	0.62	0.64	0.63	1.83	1.29	1.56	1.81	1.67	1.74
	P_3-30	0.74	0.64	0.69	2.02	1.48	1.75	2.37	1.57	1.97
	Mean	0.61	0.59	0.6	1.82	1.33	1.57	1.92	1.53	1.72
	P_1-20	0.5	0.53	0.51	1.66	1.34	1.54	1.8	1.48	1.64
	P_2-25	0.63	0.66	0.64	1.84	1.69	1.76	2.05	1.78	1.92
	P_3-30	0.74	0.73	0.73	2.29	1.91	2.1	2.48	1.93	2.21
	Mean	0.62	0.64	0.63	1.96	1.65	1.80	2.11	1.73	1.92

Table 8. Fresh weight (g plant^{-1}) of cowpea as influenced by time of sowing, spacing and seed rate

Time of sowing	Seed rate	30 DAS			60 DAS			At harvest		
		Row spacing								
		S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	Mean
D_1- Second fortnight of June	P_1-20	16.82	15.3	16.06	132.33	123.76	128.05	394.96	346.43	370.69
	P_2-25	16.5	17.2	16.85	133.96	114.76	124.36	389.04	351.43	370.23
	P_3-30	17.7	17.24	17.47	132	114.56	123.28	355.12	384.37	369.74
	Mean	17	16.58	16.79	132.76	117.7	125.23	379.7	360.74	370.22
D_2- First fortnight of July	P_1-20	12.72	15.46	14.09	116.5	118.43	117.46	359.93	281.73	320.83
	P_2-25	12	11.43	11.72	131.13	107.76	119.45	331.77	298.37	315.07
	P_3-30	13.08	8.76	10.92	96.6	96.93	96.76	326.68	298.36	312.52
	Mean	12.6	11.88	12.24	114.74	107.71	111.22	339.46	292.82	316.14
D_3- Second fortnight of July	P_1-20	14.79	13.4	14.1	108.26	106.76	107.51	305.44	305.16	305.3
	P_2-25	17.2	16.58	16.89	108.6	108.1	108.35	311.78	305.08	308.43
	P_3-30	14.38	10.3	12.34	104.93	107.26	106.1	321.68	308.44	315.06
	Mean	15.46	13.43	14.44	107.26	107.37	107.32	312.97	306.23	309.6
	P_1-20	14.78	14.72	14.75	119.03	116.32	117.67	353.44	311.11	332.27
	P_2-25	15.23	15.07	15.15	124.56	110.21	117.68	344.19	318.29	331.24
	P_3-30	15.05	12.1	13.58	111.17	106.25	108.71	334.49	330.39	332.44
	Mean	14.39	13.96	14.49	118.15	110.93	114.59	344.04	319.93	331.99

Table 9. Total dry matter accumulation (g plant^{-1}) of cowpea as influenced by time of sowing, spacing and seed rate

Time of sowing	Seed rate kg ha^{-1}	30 DAS			60 DAS			At harvest		
		Row spacing								
		S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	Mean
D_1- Second fortnight of June	P_1-20	2.58	2.39	2.49	12.73	12.2	12.46	71.03	67.83	69.43
	P_2-25	2.74	2.65	2.69	14.93	11.7	13.31	67.15	56.46	61.81
	P_3-30	2.69	2.85	2.77	11.16	11.1	11.13	62.2	55.26	58.73
	Mean	2.67	2.63	2.65	12.94	11.66	12.3	66.79	59.85	63.32
D_2- First fortnight of July	P_1-20	1.94	2.22	2.08	8.36	6.6	7.48	59.03	49.81	54.42
	P_2-25	1.91	1.79	1.85	8.23	7.73	7.98	56.42	51.05	53.74
	P_3-30	2.02	1.61	1.82	7.8	7.86	7.83	52.46	50.36	51.41
	Mean	1.96	1.87	1.91	8.13	7.4	7.76	55.97	50.4	53.19
D_3- Second fortnight of July	P_1-20	2.64	2.11	2.38	8.23	7.53	7.88	53.62	49.9	51.76
	P_2-25	2.51	2.46	2.48	7.46	7	7.23	52.78	51.96	52.37
	P_3-30	2.68	1.89	2.29	8.36	7.5	7.93	51.81	48.45	50.13
	Mean	2.61	2.15	2.38	8.02	7.34	7.68	52.73	50.1	51.42
	P_1-20	2.39	2.24	2.31	9.77	8.77	9.27	61.23	55.84	58.53
	P_2-25	2.39	2.3	2.34	10.21	8.81	9.51	58.78	53.97	55.97
	P_3-30	2.46	2.12	2.29	9.11	8.82	8.96	55.49	53.36	53.42
	Mean	2.41	2.22	2.31	9.7	8.8	9.25	58.5	53.45	55.98

Table 10. Number of pods per plant, number of seeds per pod and 1000 seed weight of cowpea as influenced by time of sowing, spacing and seed rate at harvest.

Time of sowing	Seed rate kg ha^{-1}	Number of pods (plant^{-1})			Number of seeds (pod^{-1})			1000 seed weight (g)		
		Row spacing								
		S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	Mean	S_1 (30 cm)	S_2 (45 cm)	Mean
D_1- Second fortnight of June	P_1-20	11.7	10.7	11.2	11.3	11.2	11.3	99.4	99.3	99.3
	P_2-25	11.4	9.8	10.6	10.5	10.3	10.4	100.6	99.2	99.9
	P_3-30	12.3	9.9	11.1	12.1	10.5	11.3	101.4	100.4	100.9
	Mean	11.8	10.1	11	11.3	10.7	11	100.5	99.6	100
D_2- First fortnight of July	P_1-20	8	8.1	8.1	9.1	9.6	9.3	96.6	96.9	96.7
	P_2-25	8.6	8.5	8.6	9.4	9.3	9.3	96.9	97	97
	P_3-30	8.7	8.2	8.4	9.1	9.3	9.2	97.3	96.9	97.1
	Mean	8.4	8.3	8.3	9.2	9.4	9.3	96.9	97	96.9
D_3- Second fortnight of July	P_1-20	6.2	6.9	6.5	9.1	9.4	9.2	96.7	96.4	96.5
	P_2-25	6.9	6.7	6.8	8.8	9.4	9.1	96.5	96.2	96.4
	P_3-30	7.6	6.2	6.9	9.4	9.4	9.4	96.7	96.8	96.7
	Mean	6.9	6.6	6.7	9.1	9.4	9.2	96.6	96.5	96.5
	P_1-20	8.6	8.6	8.6	9.8	10.1	9.9	97.5	97.5	97.5
	P_2-25	9	8.3	8.6	9.5	9.6	9.6	98	97.5	97.7
	P_3-30	9.5	8.1	8.8	10.2	9.7	10	98.5	98	98.2
	Mean	9	8.3	8.7	9.8	9.8	9.8	98	97.7	97.8

These findings are in consistency with the findings of Rutkowski and Fordonski (1987) for plant height and dry matter accumulation, Kurmawanshi et al. (1994) for plant height and branches per plant in field bean, Sreelatha et al. (1997) for dry matter production, leaf area and leaf area index and Begum et al. (2003) for plant height and leaf area in french bean with early sowing, Ravinder and Singh (1998) for plant height, Yadav (2003) for plant height, number of pods and test weight in cowpea.

The photosynthetic area and activity of the crop leading to better growth and yield components contributing to more seed yield might have been increased by significantly higher number of leaves, leaf area and LAI In early sowing.

In delayed sowing viz., second fortnight of July (D_3), due to the significantly lowest growth and yield components, especially leaf area and leaf area index, which might have affected the photosynthesis and intern the yield, significantly least seed yield (517 kg ha^{-1}, Table 1), haulm yield (3699 kg ha^{-1}, Table 2) and harvest index (0.24, Table 2) recorded.

Proximate Composition (quality) Seed

The contents of seed quality parameters were not affected significantly, irrespective of time of sowing. On the other hand, the crude protein content ranged from 21.97 to 22.92 per cent.

Mainly due to significantly higher seed dry matter yield recorded with D_1 compared to D_2 and D_3, the yield of all the seed quality parameters were significantly higher in June second fortnight sowing (D_1) compared to D_2 and D_3.

Due to significantly lowest seed dry matter yield, the significantly lowest yield of all the quality parameters recorded in D_3.

Haulm

Time of sowing did not significantly influence the content and yield of all the quality parameters. Mainly due to the on par haulm dry matter yield recorded for time of sowing, the non-significant yield of quality parameters were recorded.

Seed Quality

signifying that seed quality is not affected by time of sowing, time of sowing did not significantly influence the seed quality parameters namely germination percentage (87.6 to 89.0%), field emergence, root length, shoot length, total seedling length (32.4 cm to 34.3 cm) and seedling vigour index (3043.7 to 3264.4).

For germination percentage in Pea, these result are in concord with Hari and Gill (1981).

Effect Of Spacing

Growth and yield

Compared to wider row spacing of 45 cm, the closer row spacing of 30 cm produced significantly higher seed yield (741 kg ha^{-1}) and haulm yield (4196 kg ha^{-1}), which accounted 9 per cent and 5 per cent higher, respectively (Table 1, 2).

Mainly due to significantly higher performance of all the growth and yield components, there was increase in seed and haulm yield with 30 cm row spacing compared to 45 cm.

In closer spacing, compared to wider spacing, these findings are in consistency with Mc Ewen (1973) in field bean, Dwivedi et al. (1994), Singh and Tripathi (1994) in French bean, Angne et al. (1993), Arora et al. (1971) and Yadav (2003) in cowpea.

Significantly higher plant height (147.2 cm, Table 3), number of green trifoliate leaves (32.4 $plant^{-1}$, Table 4), number of branches (4.0 $plant^{-1}$, Table5), leaf area (1003.81 cm^2 $plant^{-1}$, Table 6), leaf area index (2.11, Table 7), fresh weight (344.04 g $plant^{-1}$, Table 8), total dry matter accumulation (58.50 g $plant^{-1}$, Table 9), number of pods (9.0 $plant^{-1}$, Table 10) and seed yield (09.24 g $plant^{-1}$, Table 1) were recorded in 30 cm row spacing.

These findings are in consistency with the result of Angne et al. (1993) for growth parameters and Arora et al. (1971) for plant height, lateral branches and number of trifoliate leaves in cowpea, Mc Ewen (1973) for plant height in field bean, Singh and Tripathi (1994) for plant height, branches and leaves per plant and Dwivedi et al. (1995) for plant height, number of leaves and branches per plant in french bean and Yadav (2003) for plant height.

Significantly higher number of leaves, leaf area and leaf area index which might have increased the photosynthetic area and activity of the crop leading to better growth and yield components contributing to more seed yield recorded in row spacing of 30 cm.

Due to the significantly lowest growth and yield components, significantly least seed yield (668 kg ha^{-1}) and haulm yield (3914 kg ha^{-1}) were recorded with 45 cm row spacing.

Proximate composition (quality) Seed

These outcomes are in agreement with Rajesh et al. (1998). Row spacing did not significantly influence the content and yield of all the quality parameters. Mainly due to the on par seed dry matter yield recorded for row spacing, the non-significant yield of quality parameters was recorded. On the other hand, crude protein content ranged from 22.52 to 22.58 per cent.

Haulm

Row spacing did not significantly influence the content and yield of all the quality parameters. Mainly due to the on par haulm dry matter yield recorded for row spacing, the non-significant yield of quality parameters were recorded.

Seed quality

Suggesting that seed quality is not affected by spacing, row spacing did not significantly influence the seed quality parameters namely germination percentage (87.5 to 88.0 %), field emergence, root length, shoot length, total seedling length (33.0 cm to 33.86cm) and seedling vigour index (3109.6 to 3192.8).

Effect of Seed Rate Growth and yield

The yield, growth and yield components were not influence significantly by Seed rate. However, the higher seed yield (739 kg ha^{-1}) and haulm yield (4118 kg ha^{-1}) were recorded with 25 kg ha^{-1} and 20 kg ha^{-1} seed rate, respectively. Due to the on par growth and yield components, the on par yield recorded with seed rate.

Proximate Composition (Quality) Seed

These findings are in consistency with Santiesteban et al. (2002). The content and yield of seed quality parameters were not influenced significantly irrespective of the seed rates. On the other hand, the crude protein content ranged from 22.16 per cent to 22.87 per cent. Mainly due to the on par seed dry matter yield recorded for seed rates, non-significant yield of quality parameters were recorded.

Haulm

Mainly due to the on par haulm dry matter yield, seed rate did not influence significantly the content and yield of quality parameters in haulm.

Seed quality

Seed rate did not affect significantly the seed quality parameters viz., germination percentage (88.2 to 88.3%), field emergence, root length, and shoot length, total seedling length (32.8 cm to 33.8 cm) and seedling vigour index (3104.0 to 3185.2).

IV. Conclusion

With 30 cm row spacing at 30 kg ha^{-1} seed rate, fodder cowpea sown in June second fortnight results in significantly higher seed yield (1054 kg ha^{-1}) and haulm yield (4968 kg ha^{-1}).

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