Table 3. Water use.

Irrigation regimes	Grain yield (kg ha^{-1})		Total water use (cm)		Water use efficiency (kg ha^{-1} cm)	
	1980	1981	1980	1981	1980	1981
I_1	6960	4770	117	141	59.5	33.8
I_2	7726	5445	104	104	74.3	52.4
I_3	6960	4785	95	102	73.3	46.9
I_4	6372	3981	112	98	56.9	40.6

Thus, considering the higher yeild, water economy and production efficiency, the results of the two years experiment revealed that rice Co 37 *(Vaigai)* was found more suitable than Co 41 for direct sown condition on puddled soil.

An irrigation schedule of replenishing 7 cm depth of water one day after the disappearance of ponded water was found quite optimum during *kharif* season. Besides, this practice would help the irrigation authorities in monitoring the distribution of water at weekly interval in the Periyar - Vaigai canal command. Application of nitrogen at 100 kg ha^{-1} was found sufficient for getting higher yield.

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YIELD AND HIGH DENSITY GRAIN AS INFLUENCED BY CROP DENSITY AND 'N' LEVEL IN SCENTED RICE

S.PADMAJARAO
Department of Plant Physiology, Directorate of Rice Research, Rajendra Nagar, Hydarabad 500 030

ABSTRACT

Field studies were conducted with 2 scented rice varieties (Basmati-370 and IET 8580) during *kharif* and *rabi* (1988-89) by adopting different 'N' levels (0,20,40,60 and 80) and 3 spacings (20x10; 20x15 and 20x20 cm) to assess the nature of 'N' and density of population influencing yield and high density grain. High density grain number was prominently high at 40 kg N/ha in both the seasons and further increase reflected in excessive vegetative growth and lodging during wet season. The yield and HD grain number were relatively higher during dry season. Overall, the study inferred that for exploiting potential yields and high density grain in scented rice, an optimum population of 50 hills/m^2 at 40-60 N would be sufficient.

KEYWORDS : Yield, High Density Grain, N level, Scented Rice

Scented rices have got great demand in international and national markets due to their aroma and unique cooking qualities. The traditional tall, low yielding. basmati cultures like Basmati-370 or Type-3 inspite of having high premium in the grain market cannot compete with high yielding varieties in terms of profit per hectare. Therefore, intensified efforts are needed to develop relevant technology to improve high yielding quality rices which would increase the margin of profit to farmers and also contribute to enhance the quantum of exports reflecting sizeable increase in foreign exchange. Currently, it was reported that enhancing the proportion of high density (HD) grain was considered as a promising approach for exploiting higher productivity in rice

Table 1. Plant characters and grain yield as influenced by 'N' level and density of population BASMATI - 370

Nitrogen level/ha	Spacing (cm)	Plant height (cm)	No. of tillers / m^2	LAI	TDM g/m^2	Panicle length (cm)	No. of panicles / m^2	No. of spike lets/m^2	No. of grains / m^2	1000 gr. wt. (g)	Grain yield (g/m^2)	HD grain number/ m^2	HD grain index (%)
						Kharif							
0	20 x 10	118.3	300	1.2	721	23.8	250	9210	8707	20.4	175	3454	37.5
	20 x 15	118.4	250	1.0	582	24.0	198	7895	7389	20.5	150	2000	38.0
	20 x 20	118.4	231	0.9	543	24.0	175	6421	6010	20.5	122	2453	38.2
40	20 x 10	136.6	350	2.5	882	23.8	300	17,268	16,238	20.4	318	6215	36.0
	20 x 15	137.2	330	2.0	772	27.2	245	14,632	13,695	20.5	278	5341	36.5
	20 x 20	137.8	320	1.4	590	27.3	185	11,579	10,837	20.5	220	4284	37.0
80	20 x 10	147.3	400	5.1	1103	24.6	350	19,526	18,366	20.5	342	6053	31.0
	20 x 15	150.0	363	4.1	786	27.6	310	15,210	14,307	20.5	289	4867	32.0
	20 x 20	151.4	350	4.0	692	28.2	300	12,368	11,634	20.5	235	4020	32.5
CD 5 (%)		1.6	5.5	0.3	12.7	1.4	7.0	NS	643	-	11.5	283	-
CV (%)		0.8	1.0	8.8	1.0	3.2	1.6	5.8	3.1	-	2.8	3.7	-
						Rabi							
0	20 x 10	80.2	400	1.0	740	20.7	325	21,285	19,535	20.3	240	9153	43.0
	20 x 15	85.2	330	0.8	645	21.9	267	18,338	16,448	20.3	172	7959	43.4
	20 x 20	89.3	300	0.7	595	22.8	240	16,145	13,030	20.3	165	7023	43.5
20	20 x 10	99.3	450	1.7	775	21.7	420	25,235	20,830	20.4	340	10,094	40.0
	20 x 15	101.3	396	1.4	716	21.9	315	21,483	18,718	20.4	321	8636	40.2
	20 x 20	105.4	350	1.2	702	22.9	280	17,445	15,310	20.4	272	7047	40.4
40	20 x 10	86.9	500	2.2	1050	21.2	525	30,155	19,680	20.5	410	11,459	38.0
	20 x 15	87.9	396	1.7	904	21.7	389	23,308	22,873	20.5	333	8,904	38.2
	20 x 20	88.6	375	1.5	775	22.3	223	18,665	16,060	20.5	285	7,205	38.6
60	20 x 10	93.6	600	4.1	1140	21.4	530	32,065	23,170	20.5	414	10,966	34.2
	20 x 15	94.6	462	3.7	1023	22.7	452	29,925	19,302	20.5	355	10,264	34.3
	20 x 20	98.7	400	3.2	818	22.9	380	20,865	18,062	20.5	300	7,261	34.8
80	20 x 10	98.6	650	4.8	1300	23.7	545	34,120	32,855	20.5	435	10,918	32.0
	20 x 15	104.3	495	3.7	1040	24.4	460	30,476	28,311	20.5	405	9,874	32.4
	20 x 20	105.7	425	3.4	963	24.6	392	27,873	22,822	20.5	310	9,142	32.8
CD 5 (%)		NS	12.4	0.4	12.4	NS	7.8	336	188	-	4.7	17.1	-
CV (%)		2.2	1.7	10.1	0.8	3.2	1.2	0.8	0.5	-	0.9	1.1	-

(Padmaja Rao *et al.*, 1986; Padmaja Rao, 1987). Therefore, in the present study, it was considered important to identify the possible role of nitrogen and plant population influencing HD grain in scented rice which reflects in substantial increase in grain yield as well as kernel recovery on milling (Venkateswarlu *et al.*, 1986) as these rice are valued mainly on kernel and cooking quality characteristics.

MATERIALS AND METHODS

Field studies were conducted at the Directorate of Rice Research, Rajendranagar farm, during wet (*kharif*) and dry (*rabi*) seasons of 1988-89 with two scented rice varieties (Basmati-370, IET 8580) to find out the production efficiency of HD grain with increasing nitrogen and plant density. Thirty day old seedlings were planted at a three spacings so as to give population densities of 25, 33 and 50 plants/ m2 (20x20; 20x15 and 20x10cm respectively) under different nitrogen levels during *kharif* (0, 40 and 80 N/ha) and *rabi* (0, 20, 40, 60 and 80 N/ha) in a randomized block design with three replications; N (Urea) was applied in 3 equal splits such as 50 per cent as basal and 25 per cent each at mid tillering and primordial initiation. All phosphorus and potash (30 kg P_2O_5 and 30 kg

Table 1. IET 8580

Nitrogen level/ha	Spacing (cm)	Plant height (cm)	No. of tillers/m²	LAI	TDM g/m²	Panicle length (cm)	No. of pani cles/m²	No. of Spike lets/m²	No. of gra ins /m²	1000 gr. wt. (g)	Grain yield (g.m²)	HD grain number /m²	ND (%)
						Kharif							
0	20 x 10	89.8	208	0.65	545	25.4	200	10,632	9,224	21.9	202	4465	42.0
	20 x 15	91.0	165	0.44	416	25.5	145	9,474	8,182	22.0	180	4036	42.6
	20 x 20	91.6	140	0.43	319	25.8	130	7,632	6,591	22.0	145	3282	43.0
40	20 x 10	102.2	268	1.80	870	26.4	260	17,895	15,384	22.1	340	7194	40.2
	20 x 15	106.4	260	1.65	812	26.6	231	15,263	13,064	22.2	290	6227	40.8
	20 x 20	108.8	240	1.40	796	27.8	220	12,632	10,811	22.2	240	5179	41.0
80	20 x 10	106.2	350	2.80	1103	26.6	320	20,105	17,523	21.8	382	6308	31.4
	20 x 15	108.2	330	2.52	892	26.8	260	15,842	13,498	22.3	301	4927	31.1
	20 x 20	110.0	250	2.40	840	26.9	240	14,737	12,556	22.3	280	4771	32.4
CD 5%		1.4	8	NS	10.6	NS	8	776	-	-	8.1	210	-
CV (%)		0.8	1.9	6.2	0.8	3.1	2.0	3.3	8.0	-	1.8	3.4	-
						Rabi							
0	20 x 10	69.2	550	0.55	625	23.1	290	18,100	15,695	22.0	275	8507	47.0
	20 x 15	70.0	396	0.45	495	24.2	271	14,385	11,491	22.0	252	6790	47.2
	20 x 20	71.0	375	0.40	438	24.4	265	14,195	9,113	22.0	247	6714	47.3
20	20 x 10	74.3	650	1.63	750	23.7	302	24,375	18,465	22.1	410	10969	45.3
	20 x 15	75.6	462	1.50	568	24.1	275	17,186	13,982	22.2	330	7802	45.4
	20 x 20	75.8	450	1.45	450	24.9	268	16,240	12,880	22.2	278	7438	45.8
40	20 x 10	81.7	670	1.70	950	24.4	350	27,885	24,900	22.3	422	11712	42.0
	20 x 15	82.1	462	1.55	930	24.8	287	19,978	17,012	22.3	350	8451	42.3
	20 x 20	82.5	450	1.50	870	25.0	278	18,835	14,933	22.3	288	8005	42.5
60	20 x 10	82.5	700	2.20	1015	24.5	405	28,725	26,405	22.3	431	10801	37.6
	20 x 15	82.8	505	1.75	944	24.9	333	20,572	19,553	22.3	376	7797	37.9
	20 x 20	83.4	495	1.60	840	25.2	322	20,250	16,003	22.3	312	7695	38.0
80	20 x 10	84.0	750	2.60	1255	24.7	495	33,750	28,925	22.3	450	10800	32.0
	20 x 15	84.1	561	2.00	1003	25.1	363	25,747	22,576	22.3	410	8342	32.4
	20 x 20	84.7	525	1.75	875	25.4	328	21,000	18,850	22.3	320	6888	32.8
CD 5%		NS	9.4	0.3	14.8	NS	7	461	218	-	3.8	171	-
CV (%)		2.3	1.1	11.0	1.1	3.4	1.3	1.3	0.7	-	0.6	1.2	-

K_2O/ha) were applied as basal doses and incorporated into the soil before transplanting. Appropriate plant protection measures were adopted against insects and diseases.

Data on phenological attributes such as plant height, panicle length, number of tillers, leaf area index (LAI) and total dry matter were collected during crop growth and development. At harvest, the yield and yield components (number of spikelets, grain and 1000 grain wt) were recorded. From the harvested sample, HD grains were sorted out by adopting specific gravity method (Padmaja Rao *et al.*, 1985) and HD grain index was calculated accordingly.

RESULTS AND DISCUSSION

In this study, the nature of association of different plant populations and varied nitrogen levels were studied in relation to the production of HD grain and grain yield during two seasons (*rabi* and *kharif*). Among the populations maintained (25, 33 and 50 hills/m2), plant characters such as

LAI, No. of tillers, panicles, spikelets and grains increased significantly at 50 hills/m2 with substantial increase in yield potential (Table 1). But plant height and 1000 grain weight was unaltered. In general, the two scented varieties responded better during dry season in comparison to wet season due to the occurrence of high radiation reflecting in higher photosynthesis and increased grain yields accordingly (Table 1). The LAI tended to be higher during wet season especially when the plant densities were higher. Higher 'N' contributed to enhanced total dry matter, LAI and grain yield while increase in the production of HD grain was not much significant.

High density grains

Asynchronous flowering in rice results into mixture of different grades of grain at harvest in which the proportion of potentially filled or HD grain differ among the varieties (Padmaja Rao *et al.*, 1985). Potentially filled or HD grain represents the highly filled grain submerged at 1.20 specific gravity (Padmaja Rao and Venkateswarlu, 1986). Earlier reports indicated that HD grains differ at varied cultural/management practices and environments (Padmaja Rao, 1988). It was known that the number and weight of HD grain were positively correlated with yield. In the current study, the number of HD grains was more at close spacing (20x10 cm) and was found non significant at higher N. In otherwords, higher N was reflected more in vegetative growth with a low proportion of HD grain total grain to yield. Overall, nitrogen level upto 40 N seems to be sufficient for the production of HD grains in both the seasons. However, the higher yield recorded at higher N was attributed to increased production of other yield components such as panicle number, spikelet and grain numbers as influenced by dry matter and LAI reflecting in higher photosynthetic efficiency. Besides, it was observed that at 80 N/ha due to enormous increase in plant height, Basmati-370 exhibited lodging on maturity, indicating that scented varieties are unsuitable for higher nitrogen application during wet season. These studies suggested that application of nitrogen at 40- 60 kgN/ha would be more beneficial for exploiting potentially filled grain among scented rice.

Though close spacing limits the tiller number per plant, overall increase in plant population resulted in high tiller number and total dry matter enhancing the productive capacities of the tillers through increased grain filling, to the extent of its potential capacities. Though at wider spacing, apparently though the plants produce several tillers, most of them were weak and unproductive, contributing to lower proportion of HD grain. This is mainly due to the lack of uniform distribution of assimilates among the tillers when plants are distantly placed. From the present study, it is therefore suggested that the optimum spacing would be around 20x10 cm, beyond which harvesting of HD grain would be difficult. Obviously, these observations infer that low tiller number would be highly advantageous to exploit grain of high potential capacities in scented rice which are valued mainly based on quality characteristics.

High Density (HD) Grain Index (%)

HD grain index indicates the proportion of potentially filled grain to the total number of spikelets formed (Padmaja Rao and Venkateswarlu, 1986). In otherwords, the index reflects on the grains submerged at 1.20 specific gravity and expressed in percentage. As the grain yield depends on the grain weight as the major determinant factor, HD grain index plays a key role in reflecting the proportion of potentially filled grain. In the present study, apparently the HD grain index was not much different at different spacings. This was true with the varieties and seasons as well. However, the index showed a declining trend with an increased N level. Among the seasons, the index was higher in *rabi* in comparison to *kharif* uniformly among the varieties. Overall, the study infers that the occurrence of lower HD grain index in Basmati-370 (37.5 and 43.0% during *kharif* and *rabi* respectively) and IET 8580 (42.0 and 47.0% in *kharif* and *rabi* respectively) indicates that the reason for low yield potential in scented varieties is mainly due to lack of potential grain filling. This information suggests the need to enforce future thrust among scented varieties in making use of grain filling as the major criterion so as to exploit maximum yield potential.

In brief, the results indicate that since wider spacing resulting in non uniform tillers, non uniform flowering and ripening, the production of HD grain is limited and therefore an optimum spacing of 20x10 cm is beneficial for future adoption in scented varieties. As higher nitrogen resulted in lodging and being non-responsive to HD grain, an optimum of 40-60 N/ha is being suggested. Further, the low HD grain index (37-47%) in scented varieties emphasises the need for focussing future thrust on grain filling.

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YIELD ATTRIBUTES AND YIELD OF N AND RHIZOBIUM INOCULATIONS IN SORGHUM - SOYBEAN INTERCROPPING

G.PUSHPARAJ, SJ.,G.S.THANGAMUTHU, M.R.IRUTHAYARAJ and D.PURUSHOTHAMAN

Arul Anandar College (Autonomous), Karumathur 626 514.

ABSTRACT

An experiment was conducted during September to December 1986 (*rabi* season) and February to May 1987 (summer season) on sandy loam and clay loam soils respectively under irrigation at the Tamil Nadu Agricultural University, Coimbatore, to find out the effect of N and *Rhizobium* inoculations in sorghum - soybean intercropping. It was inferred that the sorghum Co26 in double paired row intercropped with soybean Col at 50 per cent of the recommended level of N (45 kg N ha^{-1}) in combination with the indigenous Rhizobial strain, *Rhizobium japonicum* soybean 53 gave the highest grain yield of sorghum and soybean with a saving of 45 kg N ha^{-1}.

KEY WORDS : Yield, *Rhizobium* inoculation, Intercropping

In India, sorghum is being grown as a sole crop, as intercrop with pulses or mixture crops to serve as an 'harvest insurance'. The compatibility of sorghum - soybean based cropping system in terms of agronomic practices, monetary returns and improvement of soil is appreciated widely. It has become evident from the recent studies that not only total yields from intercropping can be larger than those from pure stands of sorghum. (Wiley, 1979; Anon., 1981) but also a legume as an intercrop has exercised beneficial effects on the associated non legume system (Burton *et al.*, 1983) in terms of gains in grain protein and soil N fertility and its maintenance without N fertilisation (Searl *et al.*, 1981)

MATERIALS AND METHODS

The experiments, conducted during September to December 1986 (*rabi* season) and February to May 1987 (summer season) on sandy loam and clay loam soils respectively under irrigation at the Tamil Nadu Agricultural University, Coimbatore, were laid out in split plot design with four replications. The spacing adopted for sorghum Co26 between rows was 30cm as against normal 45cm and 90cm between two rows of soybean with a plant spacing of 5cm for soybean as against normal plant spacing of 15cm. The population was maintained uniformly under the sole and intercrop system. While the main plot consists of N levels,