ORIGINAL RESEARCH ARTICLE OPEN ACCESS

Grain Quality Parameters of Cultivars as Influenced by SRI *Vs* Normal Method of Rice Cultivation

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Received: 18th March, 2015; Accepted: 20th August, 2015

Abstract

Experiments were carried out at Directorate of Rice Research, ICRISAT farm- Ramachandrapuram, during wet (*kharif*) and dry (*rabi*) seasons which included 3 cultivars (MTU 1010, Shanthi, DRRH2 during dry season and BPT 5204, DRRH 2, Swarna in Wet season) to study the performance of cultivars managed under System of Rice Intensification (SRI) compared with Normal Transplanting (NTP) method. During both the seasons, three methods of crop establishment tested were (i) Eco-SRI where 100% organic manure was applied (ii) SRI where both organic + inorganic fertilizers were applied in 50:50 ratio and (iii) Normal transplanting where 28-30 day old and 2-3 seedlings were planted in normal spacing of 20 x 15 cm with fertilizers doses similar to SRI method. In addition to grain yield, the quality characters studied includes hulling, milling, head rice recovery, kernel length, kernel breadth, L/B ratio, volume expansion ratio, water uptake, alkali spreading value, amylose content and gel consistency were recorded. During wet season grain yield was significantly higher in SRI method than Normal transplanting and Eco-SRI by 10.3 and 33.4%, respectively. Whereas, SRI and normal transplanting were on par and superior to Eco-SRI in dry season. The quality parameters showed that there was significant influence due to methods of crop establishment especially on hulling, milling, head rice recovery, and gel consistency in *rabi* season and K.L, K.B, L.B and water uptake in wet season. The traits *viz.,* alkali spread value (ASV), amylose content (AC), kernel length(KL), kernel breadth (KB) and L/B ratio were not influenced by the cultivation methods. Varietal differences were observed in hulling , milling, head rice recovery ASV, AC and GC. Interaction effect of Genotype and cultivation method was significant with hulling, milling, head rice recovery, AC and GC in dry season and KL and L.B ratio in wet season. SRI method recorded higher milling, head rice recovery values as compared to Normal transplanting method. Among the varieties, DRRH2 hybrid showed highest significant values in all the traits as compared to rest of the cultivars. Eco-SRI had very high and significant effect on gel consistency. In general, Eco-SRI and SRI reduced the water uptake in different varieties tested during *kharif* season. The better quality parameters of grain in SRI method was due to delayed senescence with enhanced photosynthesis in the lower leaves was also responsible for supply of more assimilates towards roots for maintaining higher activity and better grain filling and quality.

Key words: System of Rice Intensification, Rice Cultivars, Quality parameters

Introduction

Rice is staple food of more than half the people in the world and demand is increasing due to the growing population there by leading to the imminent shortfall with plateauing of rice yield levels in the recent decades and also increases in food prices. Despite intense efforts on varietal improvement front through conventional and also through other options like heterosis breeding, development of New Plant Type (NPT), utilization of frontier technologies like molecular breeding and genetic engineering; immediate stepping up of yields is not forthcoming to increase the rice production to the comfortable levels. In view of such a grave situation, a simple management method System of Rice Intensification (SRI) developed in Madagascar, has brought hope to many rice farmers as it claims to

accomplish more rice crop per drop of water (Laulanei, 1993 and WWF- ICRISAT, 2007). It is a combination of plant, soil, water and nutrient management practices that are employed in SRI which enhances robust root growth, corresponding increase in tillering and greater grain filling resulting in higher grain yield. Under SRI cultivation, it is well established that the root exudates to enrich large and varied microbial growth and when the soils are flooded and drained (alternate wetting and drying) it entails both aerobic and anaerobic bacteria and mycorrhizal fungi a chance to enhance plant growth (Uphoff *et al.,* 2002). Generally, long duration varieties perform better with wider spacing than short duration because of extended growth (Baloch *et al.*, 2002). However, very limited studies were carried out on comparative performance of different cultivars under SRI and Normal transplanting method with regard to grain quality aspects. Besides increasing grain yield, improving the grain quality is also important (Ravindra Babu *et al.,* 2006) in view of consumer as well as to farmers for getting high commercial value. Grain quality is complex phenomena and concentrated efforts are needed to enhance the quality of the rice. With this view an attempt is made in the present study to evaluate different cultivation methods and cultivars influence on grain yield and quality parameters.

Materials and Methods

The field experiment was conducted in *wet* (*Kharif*) and *dry* (*Rabi*) seasons at the Directorate of Rice Research-Ramachandrapuram farm in ICRISAT campus in a sandy clay loam soil. Initial soil samples were collected from three depths and were analysed for important properties using standard procedures. The soil was alkaline [pH 8.5 and 9.45 in surface (0-15 cm) and sub surface (30-60 cm) depths, respectively]; non-saline (EC- 0.47,0.67dS/m in surface and sub surface depths, respectively; with high organic carbon (0.76-1.27%) content. Available N was medium (291kg/ha); available P_2O was high (26.8 kg/ha) and available K_2O was also high (527 kg/ha) in surface layer.

The experiment was laid out in a split-plot design with cultivars as main plots (BPT 5204, Swarna & DRRH 2 in *wet;* MTU 1010, Shanti & DRRH 2 in *dry season*) and methods of crop establishment (ECO-SRI, SRI and Normal transplanting) as sub-plot treatments in four replications. In SRI and Normal transplanting, the recommended dose of N @ 100 kg/ha during *wet season* and 120 kg/ha during *dry season* was applied through 50% organics (FYM) + 50% inorganics (urea). P_2O_5 and K_2O @ 60 and 40 kg/ha were given through single super phosphate and muriate of potash, respectively, in both seasons. Whereas, in ECO-SRI method, total nutrients were supplied through organic source, FYM only. Twelve days old seedlings in Eco-SRI and SRI at a spacing of 25 x 25 cm and 30 day old seedlings in Normal transplanting at 20 x15 cm spacing were transplanted. Water management in the first two treatments was done as recommended for SRI method i.e. depending on the soil moisture content once in 3-4 days, just to keep the soil moist, while it was irrigated regularly in normal transplanted method to maintain submergence of 5 ± 2 cm. Weeding was done with the help of cono weeders once in 10 days starting from 10^{th} day after transplanting. Experiment plots were bunded with polythene sheet to a depth of 1 m for preventing the lateral seepage of water from one to other treatments. Water applied to each treatment through hose pipe is measured periodically with water meters installed at source point. The paddy samples were collected for recording quality parameters and were analysed at DRR quality laboratory. The characters studied were hulling, milling, head rice recovery (HRR), kernel length, kernel breadth, L/B ratio, alkali spreading value, amylose content and gel consistency. All the data were analysed using standard statistical methods (Gomez and Gomez, 1984) and compared by LSD tests between method of cultivation and cultivar and their interactions at 5% level of significance.

Results and Discussion

Grain yield (t/ha)

There was significant effect of cultivars and method of crop establishment on grain yield in both the seasons. Grain yield data presented in Table 1 indicated the superiority of SRI (5.27 t/ha) over normal transplanting (4.78 t/ha) and Eco-SRI (3.95 t/ha) during *wet season* by 10.3 and 33.4%, respectively. Whereas, during *dry season*, SRI (3.34 t/ha) and Normal transplanting (3.46 t/ha) were on par and both were significantly superior to Eco-SRI (1.66 t/ha). Among the varieties/hybrid tested , grain yield differences were significant with Swarna (5.33 t/ha) during *wet season* and hybrid DRRH 2 (4.12 t/ha) during *dry season* and found superior to other varieties recording maximum grain yield. The expected higher yields in SRI could not be attained especially, during *dry season* due to sub-soil alkalinity and delayed planting. Plant growth on saline and alkaline soils is mainly affected by high levels of soluble salts causing ion toxicity, ionic imbalance and impaired water balance and rice is very sensitive during early growth stage. Eco-SRI with 100% organics did not perform well during initial years of organic farming, yield reduction is expected due to slower release of nutrients and mismatch of nutrient release from organics and crop demand. Various individual practices associated with

SRI method of crop management have already identified as conducive for increasing the rice yields under irrigated production system *i.e.,* single seedling /hill (San-oh *et al.*, 2006), young seedlings (Menete *et al.*, 2008) and moderate wetting and drying soil condition (Yang *et al.*, 2004).

Quality parameters

The quality of the rice grain is an important aspect for consumer acceptability and market price and its demand for seed. The cultivation methods had significant influence during dry season on quality parameters such as hulling, milling, head rice recovery and gel consistency. However, cultivation methods had no influence on variables such as hulling, milling, head rice recovery, gel consistency, volume expansion ratio and alkali spread value in wet season. The Normal transplanting was better over SRI and Eco SRI for hulling was noticed. In milling, head rice recovery and gel consistency, SRI method was significantly better in quality parameters over the other two methods. (Table 2-3).

The varietal differences are significant in all parameters except in kernel length, kernel breadth and L/B ratio. DRRH2 was significantly superior in hulling, milling, head rice recovery in dry season. MTU 1010 had significantly high value of gel consistency over other cultivars tested in dry season. DRRH-2 was significantly superior in hulling, volume expansion ratio, water uptake and gel consistency during wet season. BPT 5204 cultivar was superior in alkali spread value gel consistency during wet season.

The interaction of varieties and methodologies was significant in hulling (Fig. 1), milling (Fig. 2), head rice recovery (Fig. 3), and GC (Fig. 4) in dry season. DRRH2 with Normal transplanting of cultivation recorded significantly highest milling, hulling, AC values while with SRI cultivation method showed significantly higher head rice recovery. ASV, KL, KB, L/B ratio were unaffected by cultivation methods in dry season. With respect to hulling, DRRH2 with - SRI method recorded highest value (80.6) and BPT-5204 with Eco-SR method recorded highest milling percent of 72.2.during wet season. The hybrid DRRH2 with normal transplanting yielded lowest value of milling (69.46%). Water uptake was very low (210) in BPT 5204 in Eco- SRI method and SRI, but highest (305) in DRRH2 with Normal method of transplanting. Gel consistency was increased phenomenally (67.7) in DRRH2 by adopting SRI method over the other two cultivars. Whereas with cultivar Swarna, SRI method increased the gel consistency significantly (63.3) over Normal transplanting (45.7) . The results indicated that there is significant interactions with cultivation methodologies with genotype with respect to quality parameters (Fig. 5-9) in wet season also. The components under SRI cultivation produced seeds with better quality due to the better filling of seeds which indicates the better food reserves in the seeds produced with these treatments might have resulted in better quality parameter. These results are in agreement with the observations of Nandisha and Mahadevappa (1984) and Uday Kumar (2005).

Conclusions

The results showed that there was significant influence of cultivation methods on some of the quality characters *viz.,* hulling, milling, head rice recovery and gel consistency. The traits *viz.,* alkali spread value (ASV), amylose content (AC), kernal length (KL), kernel breadth (KB) and L/B ratio were not influenced by the cultivation methods. Varietal differences were observed in Hulling, Milling, Head Rice recovery ASV, AC and GC. Genotype and cultivation method interactions were recorded in hulling, milling, head rice recovery, AC and GC. SRI had very high and significant effect on Milling, Head rice recovery. There was no influence of cultivation methods on grain chalkiness. Among the varieties DRRH2 showed highest significant values in all the traits. Gel consistency showed significant differences for methods and varieties. Eco-SRI had very high and significant effect on Gel consistency. In general Eco-SRI and SRI reduced the water uptake in different varieties which is desirable and better quality grain can be produced by adopting SRI method.

Acknowledgement

The authors are highly thankful to Dr. N Shobha Rani, PS, DRR for her help in the analysis of quality parameters.

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Table 1. Grain and straw yields (t/ha) as influenced by different methods of crop establishment

Treatments	Grain yield (t/ha)							
	Wet - Wet season				*Dry- Dry season*			
	BPT 5204	**Swarna**	**DRRH 2**	**Mean**	**MTU 1010**	**Shanti**	**DRRH 2**	**Mean**
Eco-SRI	3.38	4.83	3.63	3.95	1.30	0.87	2.90	1.69
SRI	5.05	6.00	4.75	5.27	3.32	1.75	4.96	3.34
Conventional	4.52	5.17	4.65	4.78	3.39	2.53	4.45	3.46
Mean	4.32	5.33	4.34		2.67	1.69	4.12	
C.D (0.05)								
Main	0.32	Sub	0.15		Main	٠,٥٨	Sub	0.60

** Interaction effects were not significant*

Table 2. Quality parameters as influenced by different methods of crop establishment in wet season

Cultivars	Methods	Hulling	Milling	HRR	ASV	AC	GC	KL	KB	L/B	Volume expansion ratio	Water Uptake
		(%)	(%)	(%)								
BPT-5204	Eco-SRI	78.83	72.2	70.4	5	24.17	77.0	5.11	1.76	2.90	4.66	210.0
	SRI	77.6	70.06	68.16	5	24.4	77.3	5.15	1.82	2.83	4.96	226.7
	Con	78.3	71.2	67.26	5	25.25	73.7	5.07	1.79	2.83	4.60	251.7
DRRH-2	Eco-SRI	80.36	69.86	46.46	4	24.7	51.0	6.75	1.99	3.39	5.30	276.0
	SRI	80.6	71.83	51.73	4.16	22.69	67.7	6.43	1.89	3.40	5.30	305.0
	Con	79.63	69.46	54.43	4	26.04	51.0	6.15	2.05	3.00	5.30	330.0
Swarna	Eco-SRI	78.2	71.03	65.06	4.66	25.87	55.0	5.15	2.09	2.46	5.46	223.3
	SRI	77.8	70.16	67.4	4.66	25.26	63.3	4.84	2.14	2.26	5.10	240.0
	Con	78.46	71.53	69.1	4.5	26.16	45.7	5.01	2.11	2.37	4.86	248.3
CD(.05) Interaction	*VXM*	*0.84*	*1.28*	*NS*	*NS*	*0.47*	*5.2*	*0.14*	*0.52*	*0.10*	*NS*	*23.6*
	MXV	*0.84*	*1.28*	*NS*	*NS*	*0.47*	*5.2*	*0.16*	*0.53*	*0.11*	*NS*	*23.6*
Mean of Methods	*Eco-SRI*	*79.1*	*71.0*	*60.6*	*4.6*	*24.9*	*61.0*	*5.7*	*1.9*	*2.91*	*5.1*	*236.4*
	SRI	*78.7*	*70.7*	*62.4*	*4.6*	*24.1*	*69.4*	*5.5*	*2.0*	*2.81*	*5.1*	*257.2*
	Conventional	*78.8*	*70.7*	*63.6*	*4.5*	*25.8*	*56.8*	*5.4*	*2.0*	*2.73*	*4.9*	*276.7*
C.D (%0.05)	*Methods*	*NS*	*NS*	*NS*	*NS*	*0.27*	*3.0*	*0.13*	*0.03*	*0.09*	*NS*	*13.6*
Mean of cultivars	*BPT 5204*	*78.24*	*71.15*	*68.61*	*5.00*	*24.61*	*76.0*	*5.11*	*1.79*	*2.85*	*4.74*	*229.4*
	DRRH2	*80.20*	*70.38*	*50.87*	*4.05*	*24.48*	*56.6*	*6.44*	*1.98*	*3.26*	*5.30*	*303.7*
	Swarna	*78.15*	*70.91*	*67.19*	*4.61*	*25.76*	*54.7*	*5.00*	*2.11*	*2.37*	*5.14*	*237.2*
C.D (0.05%)	*Cultivars*	*0.39*	*NS*	*3.59*	*0.28*	*0.27*	*3.0*	*0.07*	*0.27*	*0.05*	*0.28*	*13.64*

Table 3. Quality parameters as influenced by different methods of crop establishment in dry season

Cultivars	Methods	Hulling	Milling	HRR	ASV	AC	GC	KL	KB	L/B
		(%)	(%)	(%)						
MTU 1010	Eco-SRI	75	61.5	57	3.00	21.69	80	5.92	2.01	2.95
	SRI	75	65.5	61	3.00	22.8	78	5.72	2.06	2.78
	Con	76.5	60.8	56.6	3.00	22.65	82	5.95	1.99	2.99
Shanthi	Eco-SRI	69	58	55.3	4.00	24.72	44	6.38	2.01	3.17
	SRI	77.3	66	62	4.00	24.63	43	6.55	1.94	3.38
	Con	78	64.5	60.5	4.00	24.66	50	6.32	1.92	3.29
DRRH2	Eco-SRI	78	68.6	63.2	4.00	24.54	44	6.51	1.87	3.48
	SRI	76.5	66.8	64.5	4.00	25.7	46	6.43	1.93	3.33
	Con	79.5	68.9	62.5	5.00	26.13	42	6.32	1.92	3.29
CD(.05) Interaction	VXM	1.0	1.3	1.1	NS	0.52	4.3	NS	NS	NS
	MXV	1.0	1.3	1.1	NS	0.52	4.3	NS	NS	NS
Mean of Methods	Eco-SRI	74.00	62.70	58.50	3.67	23.65	56.00	6.27	1.96	3.19
	SRI	76.27	66.10	62.50	3.67	24.38	55.67	6.23	1.98	3.15
	Conventional	78.00	64.73	59.87	4.00	24.48	58.00	6.20	1.94	3.19
C.D (٪٠,٠٥)	Methods	2.1	1.89	1.51	NS	NS	1.5	NS	NS	NS
Mean of Cultivars	MTU 1010	75.50	62.60	58.20	3.00	22.38	80.00	5.86	2.02	2.90
	Shanthi	74.77	62.83	59.27	4.00	24.67	45.67	6.42	1.96	3.28
	DRRH2	77.50	66.63	62.73	4.00	24.97	46.67	6.42	1.91	3.37
C.D (0.05%)	Cultivars	1.3	2.2	4.2	0.30	1.4	4.28	NS	NS	NS

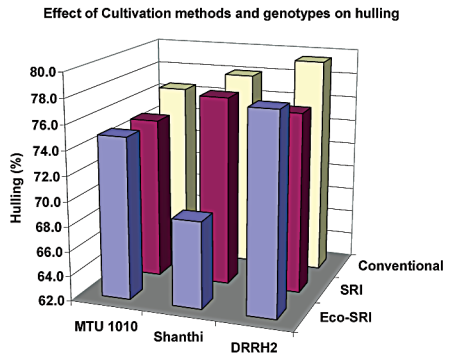

Fig. 1. Hulling

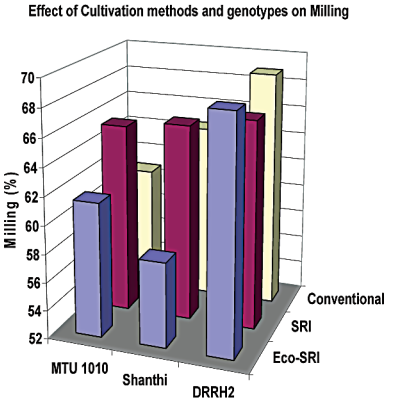

Fig. 2. Milling

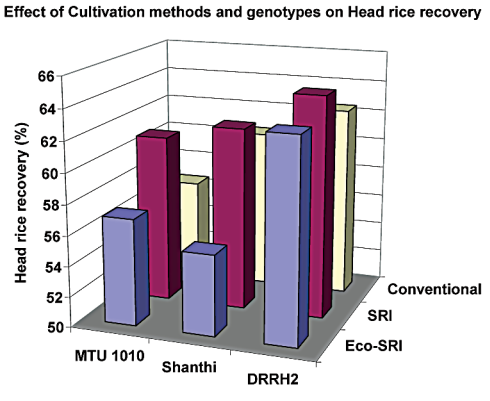

Fig. 3. Head rice recovery

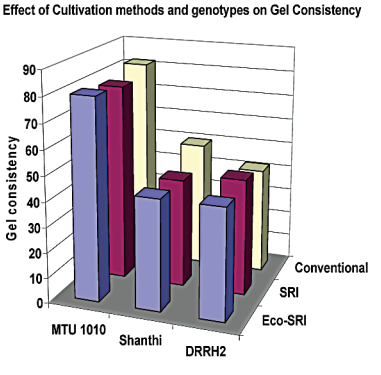

Fig. 4. Gel consistency

Fig1-4. Quality parameters as influenced significantly by methods and cultivars in dry season.

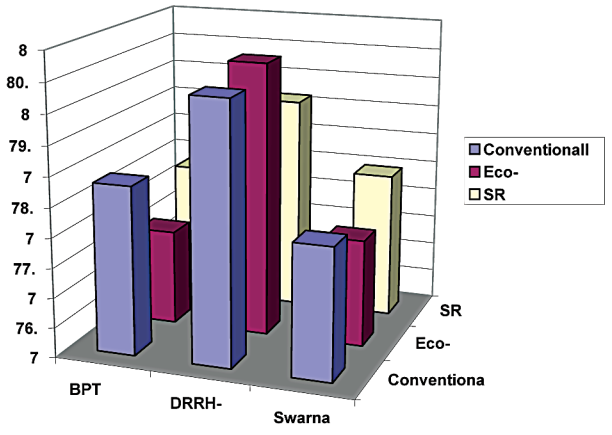

Fig. 5. Hulling

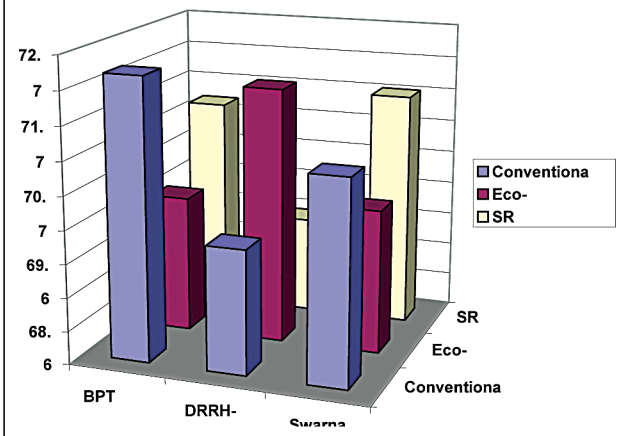

Fig. 6. Milling

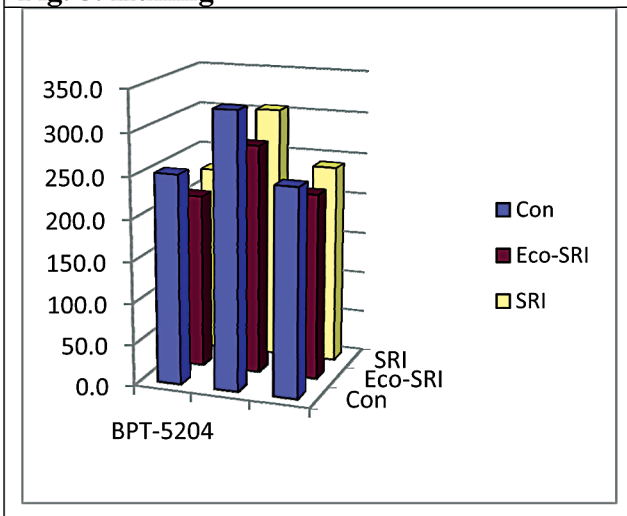

Fig. 7. Water uptake

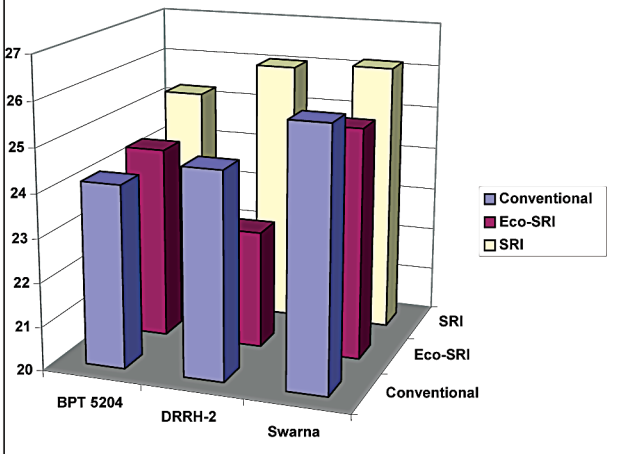

Fig. 8. Amylose content

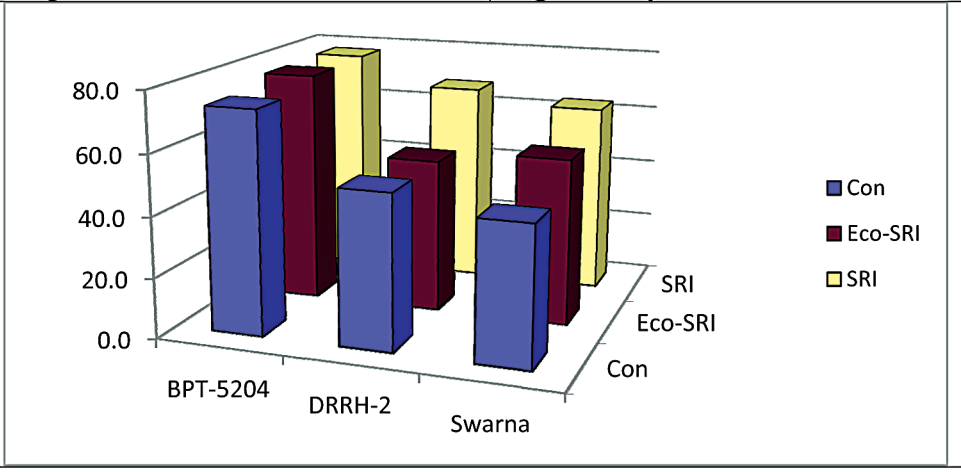

Fig. 9. Gel consistency

Fig. 5-9. Quality parameters as influenced significantly by methods and cultivars in wet season.