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Response of different varieties of mustard to nutrient levels

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Abstract
The experiment was conducted at School of Agricultural Sciences, JRNRVU, Dabok, Udaipur during *rabi* season 2024-25. The study evaluated the eight mustard varieties (DRMR 1165-40, DRMR 150-35, DRMR IJ-31, NRC 45-05-02, NRCH8-101, Radhika, Brijraj, NRL Hybrid 4G), and three nutrient levels (control, 100%, and 125% RDF). Treatments were evaluated under split plot design with three replications. Mustard variety was sown on 27th October 2024 and seed rate of each mustard variety 5 kgha^{-1}.

The results showed that among the varieties, DRMR IJ-31 proved superior with respect to growth and yield attributes and seed yield. The variety DRMR IJ-31 recorded maximum plant height, dry matter accumulation, siliqua length, number of siliquae plant^{-1} and seed yield (1279 kg ha^{-1}). Variety DRMR 1165-40 recorded maximum harvest index (30.4%) and maximum oil content (42.7%) and oil yield (542.0 kg ha^{-1}). In terms of economics, DRMR IJ-31 recorded maximum net return (4.413 ₹ ha^{-1}) and benefit: cost ratio (2.3). Among nutrient levels, application of 125% RDF proved significantly superior over 100% RDF and control treatment with respect to growth, yield attributes, seed yield, nutrient uptake, oil content, oil yield and economics. The treatment recorded maximum seed yield (1481 kg ha^{-1}), stover (3228 kg ha^{-1}) biological yield (4709 kg ha^{-1}), oil yield (576.9 kg ha^{-1}), net return (53722 ₹ ha^{-1}) and benefit: cost ratio (2.5). Overall, the study concludes that mustard variety DRMR IJ-31 along with application of 125% RDF was found most productive and economically profitable under the experimental conditions.

Keyword: Mustard, varieties, nutrient levels, growth, seed yield, nutrient uptake

Introduction
Mustard is second most important edible oil seed crop after soybean and known by the name of Indian mustard, belongs to the family Brassicaceae (Cruciferae), genus *Brassica* and species *juncea*. While mustard is named 'rai' or 'laha'. Oilseed crop plays a vital role in Indian economy. Among oilseed crops, mustard occupies an important position in the Indian agricultural economy. In India, rapeseed-mustard contributes nearly 30% of the total oilseed production and is the second most important oilseed crop after soybean (Directorate of Rapeseed-Mustard Research, 2022). The crop is grown on about 8.66 million hectares with a production of around 12.67 million tonnes and an average productivity of about 1463 kg ha^{-1} overall country (Agricultural Statistics at a Glance, 2024-25). Major mustard-growing states in India include Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and West Bengal, with Rajasthan contributing the largest share in area and production.

Selection of varieties with perfect plant type and proper nutritional support particularly nitrogen, phosphorus and potassium need to be identified. Yield and quality of the oil is mainly dependent upon genotype but interrelationship between genotypes and fertilizers needs to be evaluated.

Nutrient management is one of the most important factors influencing the growth, yield and quality of mustard. Adequate and balanced application of essential major nutrients such as nitrogen, phosphorus and potassium enhances growth and yield as well as quality of the crop. Nitrogen promotes vigorous vegetable growth, chlorophyll content and protein synthesis, resulting in improved growth characters of plants. Phosphorus also plays a vital role in root formation and early crop establishment. Potassium regulates various physiological processes including enzyme activation, photosynthesis thereby improving stress tolerance, seed filling

and overall crop quality. Balance application of nitrogen, phosphorus and potassium is therefore essential for maximizing nutrient use efficiency and enhancing productivity

Materials and methods

The experiment was conducted during *Rabi* 2024-25at the Instructional Farm, Department of Agronomy, School of Agricultural Sciences, JRNRVU, Dabok, Udaipur. The experiment consisted of eight mustard varieties (DRMR 1165-40, DRMR 150-35, DRMR IJ-31, NRC 45-05-02, NRCH8-101, Radhika, Brijraj, NRL Hybrid 4G), and three nutrient levels (control, 100%, and 125% RDF). Treatments were evaluated under split plot design with three replications. The mustard varieties was sown on 27th October 2024 as per treatments. A uniform seed rate of 5 kg ha-1 was used at inter row spacing of 30 cm. The experimental field was clay loam having high in nitrogen and potassium and medium in phosphorus with pH 7.1 and EC 0.9 dsm^{-1}. As per recommendation, fertilizers application were made through urea, MOP and SSP per plot. Full dose of P_2O_5 and K_2O and half dose of N at sowing followed by irrigation and half dose of N was applied as top dressing manually at first irrigation.

Results and discussion

Effect of varieties

Growth attributes

The mustard varieties significantly influenced the growth characters at all growth stages Table 1 and 2. It was recorded that plant height as well as dry matter accumulation. Variety DRMR IJ-31 recorded the maximum plant height, which remained at par with DRMR 1165-40. The superiority of DRMR IJ-31 in growth characters might be attributed to its better genetic potential, efficient nutrient utilization and enhanced photosynthetic activity, which promoted vigorous vegetative growth and accumulation of assimilates. Higher dry matter accumulation under DRMR IJ-31 may also be due to greater leaf area development and improved translocation of photosynthates from source to sink. Similar findings regarding varietal differences in growth characters of mustard were also reported by several researchers who observed that genetic makeup and differential nutrient absorption capacity of varieties significantly influence crop growth and biomass production (Shivran *et al.*, 2022) [11].

Yield attributes and yield

The data presented in Table 3 to 4 revealed that yield attributes of mustard *viz*., number of branches $plant^{-1}$, siliqua length, siliquae $plant^{-1}$, seeds $siliqua^{-1}$, 1000-seed weight and seed yield $plant^{-1}$ were affected significantly performed course of study. The highest yield attributes was recorded under DRMR IJ-31 like highest number of branches $plant^{-1}$ (4.9), siliqua length (7.6 cm), number of siliquae $plant^{-1}$ (211.8), but maximum seeds $siliqua^{-1}$ (15.2) in NRCH8-101, While the highest 1000-seed weight (5.0 g) and seed yield $plant^{-1}$ (6.1 g) was recorded under DRMR IJ-31. The higher yield attributes observed under DRMR IJ-31 may be attributed to better vegetative growth, efficient translocation of assimilates and higher sink capacity of the variety. The improved reproductive growth under superior varieties might also be due to enhanced photosynthetic efficiency and balanced partitioning of assimilates towards developing siliquae and seeds. The varietal differences observed in yield attributes are in close conformity with earlier findings reported by Singh and Meena (2004) and Lal *et al.*, (2025) [6, 8, 12].

The maximum seed yield (1279 kg ha^{-1}), straw yield (3044 kg $ha^{-1)}$ was recorded under DRMR IJ-31 may be attributed to its better performance in growth parameters and yield attributes such as higher dry matter accumulation, siliqua length and number of siliquae $plant^{-}$. Whereas, among the tested varieties, DRMR 1165-40 was recorded the highest harvest index (30.4%). The differences among varieties in yield performance may be due to their inherent genetic variability, nutrient utilization efficiency and adaptability under prevailing agro-climatic conditions. Similar observations regarding varietal influence on seed yield and harvest index in mustard have also been reported by Lal *et al.*, 2020 [5].

Nitrogen content and uptake

The nutrient content and uptake of mustard (Table 6) reveals that different mustard varieties failed to exert significant influence on nitrogen, phosphorus and potassium content and uptake in seed and stover. While in Variety DRMR IJ-31 recorded maximum potassium uptake by seed (6.3 kg ha^{-1}). The slight variation observed among varieties may be attributed to differences in genetic makeup and nutrient accumulation behaviour. Similar findings have also been reported by various researchers who observed non-significant variation in nutrient concentration among mustard varieties (Singh *et al.*, 2020) [13]. Variety DRMR IJ-31 recorded comparatively higher nutrient uptake values, which may be attributed to its higher seed yield, biological yield and greater dry matter accumulation. Nutrient uptake is largely governed by biomass production and nutrient concentration in plant tissues; therefore, varieties producing higher yield generally recorded greater nutrient uptake. The enhanced nutrient uptake under superior varieties might also be due to better root development and efficient nutrient absorption capacity (Meena *et al.*, 2020) [8].

Oil content and oil yield

Different varieties performed about a significant variation in oil content of seed. The results in Table 7 indicated that the different mustard varieties significantly influenced oil content. Among the tested varieties, DRMR 1165-40 recorded the highest oil content (42.7%) and oil yield (542.0 kg ha^{-1}) which proved significantly superior over all other varieties. The higher oil content and oil yield under DRMR 1165-40 may be attributed to its superior genetic potential for oil synthesis and better translocation of photosynthates towards seed development. Oil yield is a combined effect of seed yield and oil content; therefore, varieties producing higher seed yield along with better oil concentration recorded greater oil yield. The varietal variation in oil content and oil yield observed in the present investigation is in close agreement with findings reported by earlier researchers in mustard crop (Sondhiya *et al.*, 2019; Singh *et al.*, 2020) [13, 14].

Economics

The results (Table 8) among the varieties, DRMR IJ-31 recorded the highest net return (₹43413 ha^{-1}) and benefit: cost ratio (2.3). The higher economic returns under these varieties may be attributed to their superior seed yield, oil

yield and better productivity under the prevailing conditions. Higher benefit: cost ratio indicates greater economic efficiency and profitability of these varieties. The differences in economics among varieties may primarily be due to variation in yield potential and marketable produce. Similar findings regarding varietal influence on economics of mustard cultivation have also been reported by Lal *et al.*, (2025) [6].

Effect of nutrient levels

Growth parameters

Data presented in Table 1 further reveal that nutrient levels exerted significant influence on plant height and dry matter accumulation at 30,60,90 DAS and harvest stages with application of 125% RDF recorded. The improvement in growth parameters under higher nutrient levels may be attributed to adequate and balanced supply of nutrients, which enhanced cell division, cell elongation and photosynthetic activity resulting in vigorous vegetative growth. Nitrogen plays a major role in chlorophyll formation and protein synthesis, while phosphorus promotes root development and energy transfer, thereby improving nutrient absorption and crop growth (Meena *et al.,* 2020). Enhanced dry matter accumulation under higher nutrient levels might also be due to greater leaf area development and efficient translocation of photosynthates from source to sink (Choudhury and Maity (2026) [2, 8].

Yield parameters

The data further reveals that nutrient levels significantly influenced number of branches plant^{-1}. Application of 125% RDF recorded the maximum number of branches plant^{-1} (4.9), siliqua length (6.1 cm) siliquae plant^{-1} (205.3) number of seeds siliqua^{-1} (15.6), 1000-seed weight (5.0 g) and seed yield plant^{-1} (6.2 g). The improvement in yield attributes under higher nutrient levels may be attributed to better nutrient availability throughout crop growth period, which promoted vegetative growth, enhanced photosynthetic efficiency and improved translocation of assimilates towards reproductive organs. Adequate nutrient supply also favoured proper flowering, siliqua formation and seed development, thereby resulting in higher number of siliquae and seeds per siliqua. Higher test weight under increased nutrient levels may be due to better seed filling resulting from enhanced photosynthate accumulation (Lal *et al.,* 2020) [5].

Seed yield, stover yield, biological yield and harvest index of mustard as influenced by different nutrient levels are presented in Table 4. Application of 125% RDF recorded significantly higher seed yield (1481 kg ha^{-1}), stover yield (3228 kg ha^{-1}), biological yield (4709 kg ha^{-1}) and harvest index (31.5%). Enhanced nutrient availability improved photosynthetic activity, dry matter production and efficient partitioning of assimilates towards economic yield, resulting in higher seed production. Higher stover and biological yield under increased nutrient levels may also be due to vigorous vegetative growth and greater biomass accumulation. Harvest index was also significantly improved under higher nutrient levels, indicating efficient conversion of total biomass into economic yield (Kumar *et al.,* 2017) [3].

Nutrient content and uptake: Different nutrient levels failed to significantly influence nitrogen, phosphorus content in seed but nutrient levels significantly influenced in stover. Application of 125% RDF recorded significantly higher potassium content in seed (0.49%). Application of 125% RDF recorded maximum nutrient content nitrogen (0.53%), phosphorus (0.28%) and potassium (1.3%) was recorded in stover. Adequate nutrient supply might have improved metabolic activities, nutrient translocation and accumulation within plant tissues. Higher potassium concentration under increased nutrient levels may also be due to its important role in enzyme activation, photosynthesis and translocation of assimilates Kumawat *et al.,* (2014) [4].

Nutrient levels significantly influenced uptake by seed. Application of 125% RDF recorded maximum nitrogen uptake by seed (34.4 kg ha^{-1}), phosphorus uptake by seed (7.5 kg ha^{-1}) and potassium uptake by seed (7.3 kg ha^{-1}) significantly higher nitrogen uptake by stover (17.2 kg ha^{-1}) phosphorus uptake by stover (8.9 kg ha potassium uptake by stover (40.3 kg ha^{-1}) total nitrogen uptake. Application of 125% RDF recorded maximum total nitrogen uptake (51.7 kg ha^{-1} total phosphorus uptake (16.4 kg ha^{-1}), total potassium uptake (47.6 kg ha^{-1}). The enhanced nutrient uptake under higher nutrient levels may be attributed to increased nutrient availability in soil coupled with higher seed and biological yield. Nutrient uptake is a function of nutrient concentration and dry matter production; therefore, treatments producing higher biomass and yield recorded greater uptake values. Adequate nutrient supply under higher nutrient levels also promoted better root growth and nutrient absorption efficiency, resulting in higher uptake of major nutrients (Rundala *et al.,* 2012) [10].

Oil content and oil yield: The data further reveals that nutrient levels significantly influenced oil content of mustard. Application of 125% RDF recorded maximum oil content (38.9%) and maximum oil yield (576.9 kg ha^{-1}), which was significantly superior over 100% RDF and control. The increase in oil content under higher nutrient levels may be attributed to balanced nutrient availability, which improved metabolic activities involved in oil synthesis and accumulation in seeds. Adequate supply of nitrogen, phosphorus and potassium might have enhanced enzyme activity, photosynthesis and translocation of assimilates towards seed development, thereby improving oil synthesis (Neha *et al.,* 2014) [9]. Higher oil yield under increased nutrient levels may be due to combined effect of higher seed yield and increased oil content.

Economics: The data further reveals that nutrient levels significantly influenced benefit: cost ratio. Application of 125% RDF recorded maximum net return (₹53722 ha^{-1}), and benefit: cost ratio (2.5), which was significantly superior over 100% RDF and control. The higher economic returns under increased nutrient levels may be attributed to higher seed yield, biological yield and oil yield obtained under adequate nutrient supply. Although cost of cultivation increased with increasing nutrient levels due to additional expenditure on fertilizers, the increase in productivity was sufficiently high to compensate for the additional cost and resulted in higher profitability (Luqman *et al.,* 2026) [7].

Table 1: Effect of nutrient level on plant height of different mustard varieties

Treatments	Plant height (cm)			
	At 30 DAS	At 60 DAS	At 90 DAS	At harvest
Variety				
DRMR 1165-40	23.1	159.5	159.1	163.7
DRMR 150-35	18.5	141.7	141.5	151.5
DRMR IJ-31	23.9	160.4	160.8	169.5
NRC 45-05-02	16.7	116.0	122.1	131.7
NRCH8-101	21.1	148.7	152.2	156.7
Radhika	21.2	153.6	157.1	161.7
Brijraj	20.9	148.5	150.7	154.8
NRL Hybrid 4G	18.2	134.3	135.0	142.0
S.Em.±	0.9	6.6	6.9	7.3
C.D. (P= 0.05)	3.1	22.1	23.0	NS
Nutrient levels				
Control	17.6	119.0	118.2	130.8
100% RDF	21.1	157.6	160.2	163.8
125% RDF	22.7	159.4	163.7	167.3
S.Em.±	0.4	3.4	3.4	3.3
C.D. (P= 0.05)	1.3	10.3	10.3	10.0

Table 2: Effect of nutrient level on dry matter accumulation of different mustard varieties

Treatments	Dry matter accumulation (g plant-1)			
	At 30 DAS	At 60 DAS	At 90 DAS	At harvest
Variety				
DRMR 1165-40	5.0	36.0	94.1	96.3
DRMR 150-35	4.0	24.3	71.3	73.3
DRMR IJ-31	5.0	36.3	103.3	105.8
NRC 45-05-02	3.8	20.5	64.9	65.1
NRCH8-101	4.5	26.4	82.8	84.1
Radhika	4.7	34.1	83.4	87.9
Brijraj	4.0	21.4	69.0	70.4
NRL Hybrid 4G	3.8	20.7	65.8	67.8
S.Em.±	0.2	1.3	3.5	3.8
C.D. (P= 0.05)	0.5	4.4	11.8	12.6
Nutrient levels				
Control	2.7	20.6	51.1	66.6
100% RDF	4.9	27.9	82.6	84.6
125% RDF	5.5	33.8	104.3	92.8
S.Em.±	0.1	0.7	1.7	1.4
C.D. (P= 0.05)	0.2	2.1	5.1	4.2

Table 3: Effect of nutrient level on yield attributes of different mustard varieties

Treatments		Yield attributes				
	Number of branches plant-1	Length of seliqua (cm)	Number of siliquea plant-1	Number of seeds siliquae-1	1000 seeds weight (g)	Seed yield plant-1 (g)
Variety						
DRMR 1165-40	4.8	5.6	194.7	14.0	4.7	6.1
DRMR 150-35	4.9	5.4	203.0	14.2	4.8	5.2
DRMR IJ-31	4.9	7.6	211.8	14.2	5.0	6.1
NRC 45-05-02	4.9	5.0	113.5	13.0	4.4	4.9
NRCH8-101	4.4	5.9	207.6	15.2	4.9	5.6
Radhika	4.6	6.4	211.1	14.8	4.9	6.0
Brijraj	4.9	5.8	204.8	14.8	4.9	5.4
NRL Hybrid 4G	4.8	5.3	202.0	13.2	4.6	4.9
S.Em.±	0.2	0.2	7.8	0.4	0.2	0.2
C.D. (P= 0.05)	NS	0.7	26.0	NS	NS	0.8
Nutrient levels						
Control	4.6	5.7	174.8	12.7	4.5	4.6
100% RDF	4.8	5.8	200.6	14.2	4.8	5.8
125% RDF	4.9	6.1	205.3	15.6	5.0	6.2
S.Em.±	0.1	0.1	4.3	0.2	0.1	0.1
C.D. (P= 0.05)	0.2	0.2	12.9	0.6	0.3	0.4

Table 4: Effect of nutrient level on yield and harvest index of different mustard varieties

Treatments	Yield (kg ha-1)			Harvest index (%)
	Seed	Stover	Biological	
Variety				
DRMR 1165-40	1261	2835	4096	30.4
DRMR 150-35	1038	2803	3841	26.7
DRMR IJ-31	1279	3044	4323	29.7
NRC 45-05-02	1025	2911	3936	23.3
NRCH8-101	1080	2765	3845	27.5
Radhika	1138	2788	3926	28.2
Brijraj	1040	2735	3775	26.2
NRL Hybrid 4G	1029	2813	3842	25.9
S.Em.±	44.5	83.2	117.9	0.7
C.D. (P= 0.05)	148.9	NS	NS	2.5
Nutrient levels				
Control	597	2495	3092	18.8
100% RDF	1255	2788	4043	31.4
125% RDF	1481	3228	4709	31.5
S.Em.±	21.9	38.8	45.0	0.5
C.D. (P= 0.05)	65.6	116.3	134.8	1.4

Table 5: Effect of nutrient level on NPK content in seed and stover of different mustard varieties

Treatment	N Content (%)		P Content (%)		K Content (%)	
	Seed	Stover	Seed	Stover	Seed	Stover
Variety						
DRMR 1165-40	2.3	0.51	0.49	0.26	0.46	1.2
DRMR 150-35	2.3	0.52	0.49	0.27	0.49	1.2
DRMR IJ-31	2.2	0.48	0.48	0.25	0.49	1.2
NRC 45-05-02	2.2	0.47	0.47	0.24	0.45	1.1
NRCH8-101	2.3	0.53	0.50	0.27	0.47	1.2
Radhika	2.3	0.50	0.49	0.25	0.47	1.2
Brijraj	2.3	0.51	0.49	0.25	0.47	1.2
NRL Hybrid 4G	2.4	0.50	0.52	0.25	0.46	1.3
S.Em.±	0.1	0.02	0.02	0.01	0.02	0.0
C.D. (P= 0.05)	NS	NS	NS	NS	NS	NS
Nutrient levels						
Control	2.2	0.46	0.48	0.23	0.45	1.2
100% RDF	2.3	0.51	0.49	0.26	0.47	1.2
125% RDF	2.3	0.53	0.51	0.28	0.49	1.3
S.Em.±	0.0	0.01	0.01	0.00	0.01	0.0
C.D. (P= 0.05)	NS	0.03	NS	0.01	0.02	0.1

Table 6: Effect of nutrient level on NPK uptake by seed and stover of different mustard varieties

Treatment	N uptake (kg ha-1)			P uptake (kg ha-1)			K uptake (kg ha-1)		
	Seed	Stover	Total	Seed	Stover	Total	Seed	Stover	Total
Variety									
DRMR 1165-40	28.8	14.5	43.3	6.2	7.5	13.7	5.9	35.1	40.9
DRMR 150-35	23.9	14.8	38.6	5.1	7.8	12.9	5.2	34.7	39.8
DRMR IJ-31	28.5	14.6	43.2	6.2	7.5	13.7	6.3	36.4	42.7
NRC 45-05-02	23.1	13.7	36.7	4.9	6.9	11.9	4.6	33.0	37.6
NRCH8-101	25.0	14.6	39.6	5.5	7.5	12.9	5.2	33.1	38.3
Radhika	26.0	14.2	40.1	5.6	7.1	12.7	5.5	33.1	38.5
Brijraj	23.9	14.0	37.9	5.1	6.9	12.0	5.0	32.4	37.4
NRL Hybrid 4G	25.0	14.2	39.2	5.6	7.0	12.6	4.8	37.0	41.9
S.Em.±	1.4	0.6	1.8	0.4	0.3	0.6	0.1	1.4	1.4
C.D. (P= 0.05)	NS	NS	NS	NS	NS	NS	0.4	NS	NS
Nutrient levels									
Control	13.7	11.5	25.2	2.9	5.7	8.5	2.7	29.0	31.7
100% RDF	28.4	14.2	42.7	6.2	7.2	13.4	5.8	33.8	39.6
125% RDF	34.4	17.2	51.7	7.5	8.9	16.4	7.3	40.3	47.6
S.Em.±	1.0	0.3	1.0	0.2	0.2	0.2	0.1	0.8	0.9
C.D. (P= 0.05)	3.0	0.9	3.0	0.5	0.5	0.7	0.4	2.5	2.6

Table 7: Effect of nutrient level on oil content and oil yield of different mustard varieties

Treatments	Oil Content (%)	Oil yield (kg ha-1)
Variety		
DRMR 1165-40	42.7	542.0
DRMR 150-35	37.8	399.8
DRMR IJ-31	36.6	469.6
NRC 45-05-02	36.2	390.6
NRCH8-101	35.2	388.1
Radhika	35.4	408.7
Brijraj	33.8	360.8
NRL Hybrid 4G	38.5	395.1
S.Em.±	1.2	28.4
C.D. (P= 0.05)	4.1	95.0
Nutrient levels		
Control	35.0	213.2
100% RDF	37.2	467.9
125% RDF	38.9	576.9
S.Em.±	0.6	11.1
C.D. (P= 0.05)	1.7	33.3

Table 8: Effect of nutrient level on economics of different mustard varieties

Treatments	Net return (₹ ha-1)	B:C ratio
Variety		
DRMR 1165-40	42319	2.2
DRMR 150-35	28953	1.8
DRMR IJ-31	43413	2.3
NRC 45-05-02	28173	1.8
NRCH8-101	31473	1.9
Radhika	34953	2.0
Brijraj	29073	1.8
NRL Hybrid 4G	28413	1.8
S.Em.±	2671	0.1
C.D. (P= 0.05)	8932	0.3
Nutrient levels		
Control	5252	1.2
100% RDF	41066	2.2
125% RDF	53722	2.5
S.Em.±	1312	0.0
C.D. (P= 0.05)	3935	0.1

Conclusion

On the basis of result obtained from the present investigation it may be concluded that cultivation of mustard variety DRMR IJ-31 along with application of 125% RDF was found most productive and economically profitable under agro climatic zone IV-A (Sub-humid Southern Plains and Aravalli Hills of Rajasthan) variety. DRMR 1165-40 also proved promising particularly with respect to oil content, oil yield. However, these are one year results and need further experimentation for final recommendation.

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