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THE PRODUCTIVITY OF *Brassica rapa* var. YELLOW SARSON AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT PRACTICES AND SEED PRIMING IN EASTERN INDIAN SUB-HIMALAYAN PLAINS

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ABSTRACT

A field experiment was conducted during rabi 2007-08 to 2008-09 at Uttar Banga Krishi Viswavidyalaya, Cooch Behar situated at sub-Himalayan plains popularly known as terai region of West Bengal, India to study the productivity of yellow sarson under different nutrient management practices and seed priming methods. The experiment was laid out in a factorial randomized block design with eight nutrient management practices and three seed priming methods. The results showed marked improvement in yield components, productivity and economics of yellow sarson due to integrated nutrient management and seed priming methods. Significantly highest seed yield (1374 kg ha^{-1}) was recorded with combination comprising FYM + *Azotobacter* + PSB and 75% of the recommended fertilizers. The integrated nutrient management practice also had greater impact in production economics, sustenance in soil fertility and enrichment of soil nutrients. The crop receiving plant nutrients only from chemical sources showed poor productivity leading to less remuneration. Higher seed oil content (41.8% and 42.2%) was obtained with the application of 100% of the recommended dose (60:30:30 kg $N:P_2O_5:K_2O$ kg ha^{-1}) along with sulphur (20 kg ha^{-1}) but the oil yield was not impressive due to poor seed yield. Pre-sowing soaking of seeds with 100 ppm KH_2PO_4 also showed improvement in yield components, productivity and oil yield of the yellow sarson crop compared to seeds soaked with 100 ppm Na_2HPO_4 and water. Net returns and return/rupee invested were higher when the yellow sarson seeds were soaked with 100 ppm KH_2PO_4 over the other soaking methods. Variations in residual fertility were not discernible due to seed soaking.

Keywords: Economics, Integrated Nutrient Management (INM), Productivity, Seed soaking, Yellow sarson

INTRODUCTION

In India, Rapeseed-mustard (*Brassica* sp) is the most important edible oilseed after groundnut sharing in the oilseed economy. This energy rich crop plays an important role in human nutrition and animal feed, occupying a key position in the diet of Indian masses.

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Rapeseed-mustard is a common rabi crop cultivated over 8000 ha in the Sub-Himalayan plains which is situated in the northern fringe of eastern Indian state of West Bengal. Though rapeseed-mustard is the major oilseed in this region, the productivity is very poor (491 kg ha^{-1}) compared to the state average productivity (889 kg ha^{-1}). The poor productivity is attributed to the imbalanced fertilization in sub-optimal doses. Maintaining optimum plant stand is a challenge influencing desired productivity. As a result the cultivation of rapeseed-mustard is now becoming less remunerative to the farmers of this region and as a consequence the area under rapeseed-mustard is gradually decreasing due to shifting towards winter maize, vegetables and potato. Some workers consider lack of use of sufficient amount of organic matter in the nutrient management programme to be a major reason for decline in fertilizer use efficiency (Bourguignon, 2005). So to maintain long-term soil health and crop productivity in intensive cropping system have underlined the need for integrated nutrient sources such as chemical fertilizers, organic manures, bio-fertilizers etc. (Hegde et al.,1999). In the terai region of West Bengal, poor crop stand establishment of yellow sarson also occurs due to heterogeneity in the seed lots and some where after harvesting of the kharif rice, the residual moisture decreases rapidly, mostly in the upland situation due to porosity of soil which sometimes causes poor emergence of rapeseed-mustard, leading to poor productivity. In this context, pre-sowing seed soaking not only homogenizes a seed lot, but this practice also gives a good crop stand to combat the adverse field condition like moisture stresses, suboptimal and optimal temperature stresses. It enhances metabolic activities and respiration rates by activating of enzymes involved in metabolism of seed reserves (Mauromicale and Cavallro, 1995) which gives seed an earlier and increased germination, better and uniform field establishment. Increased seed and oil yield in Indian mustard can be achieved through treating the seeds before sowing (Paul et al., 1999). Keeping the above facts under consideration, this field experiment was undertaken.

MATERIALS AND METHODS

The field investigation was carried out during two consecutive years, of rabi, 2007-08 and 2008-09 at Uttar Banga Krishi Viswavidyalaya, West Bengal with different treatment combinations tested on *Brassica rapa* var. yellow sarson. The experimental soil was slightly acidic in reaction (pH-6.14), sandy loam in texture having mineralizable N 216.4 kg ha^{-1}, available P_2O_5 46.5 kg ha^{-1}, available K_2O 147. 5 kg ha^{-1} and available $SO_4^{=}$ 35.2 kg ha^{-1}. The experiment was laid out in factorial Randomized Block Design with twenty four treatment combinations and replicated thrice. The treatments comprised of the combination of different fertility levels (eight) based on integrated nutrient management practices (F_1=60:30:30 Kg N-P_2O_5 -K_2O ha^{-1} as recommended dose; F_2=100% recommended dose + Sulphur (20 kg ha^{-1}); F_3=75% recommended dose + 5 t ha^{-1} FYM; F_4=75% recommended dose + 5 t ha^{-1} Vermicompost; F_5=75% Recommended Dose + 5 t ha^{-1} FYM + Bio-fertilizer- *Azotobacter* (5 kg ha^{-1}); F_6= 75% Recommended Dose + 5 t ha^{-1} FYM + Bio-fertilizer- P.S.B(5 kg ha^{-1}); F_7= 75% Recommended Dose + 5 t ha^{-1} FYM+ *Azotobacter* (5 kg ha^{-1})+ P.S.B(5 kg ha^{-1}); F_8= 75% Recommended Dose + 5 t ha^{-1} FYM+ Sulphur (20 kg ha^{-1}) and three different seed priming methods *viz.*, with water and agro-chemicals (P_0= water soaking; P_1= pre-sowing seed soaking in 0.01% Na_2HPO_4/100ppm; P_2= pre-sowing seed soaking in 0.01% KH_2PO_4/100ppm).

In treatment combination under study, the organic manure was applied along with chemical fertilizers and bio-fertilizers, based on blanket application in lieu of nutrient content as the nutrient content in organic manure varies widely with location, raw materials and production process. Use of secondary nutrient like S has also been included in the treatment combination considering the higher requirement of S by yellow sarson. The variety used in the experiment was NC-1, popularly known as Jhumka, takes about 95-100 days to mature. Fertilizers were applied in the plots as per treatments just after laying out of the experiment. Nitrogen and potash were applied as basal and top dressing. Nitrogen was applied in two splits (½ as basal and rest ½ as top dressing at 37 and 39 days after sowing during I and II year respectively) while ¾ potassium was applied during final land preparation with ¼ as top dressing at 37 days after sowing during 1 year and 39 days after sowing during 2 year. Entire phosphatic fertilizers were applied as basal. The sources of P was DAP, while the same fertilizer and urea along with MOP were served as the sources of N and K respectively. Sulphur was applied in the form of elemental sulphur just after the application of chemical fertilizers as per the treatment schedule and mixed thoroughly with soil. Boron was applied in each plot equally in the form of Borax @10 kg ha^{-1}. Well decomposed FYM, Vermicompost, *Azotobacter* and PSB were applied as per treatments and mixed thoroughly with the soil sixth and fifth days of application of chemical fertilizers and sulphur in the first and second year respectively. For seed treatments, solutions were prepared by dissolving 0.1 g of Na_2HPO_4 and KH_2PO_4 in distilled water and volume was made up to 1000 ml. Keeping the seed rate of *yellow sarson* as 6.0 kg ha^{-1}, the seed rate for the each experimental plot sized 12 sq,m was calculated and that quantity of seeds were placed in different containers used for different plots and treatments accordingly. After that the seeds were soaked with water, Na_2HPO_4 and KH_2PO_4 as per the treatment schedule and allowed to absorb moisture up to 35% of their weight and kept in imbibed condition for 6 hrs and the seeds were then spread out in a thin layer for drying under shade before sowing. The sowing was done on 03 November and 31 October in the first and second year of experimentation respectively. Seeds were sown in lines in both the years with the help of duck foot tyne by opening a shallow furrow at uniform depth (2.5 to 3.0 cm), keeping the rows 30 cm apart. The seeds were covered immediately after sowing. For maintaining appropriate plant to plant distance, thinning was done. In both the years, thinning was performed once at 14 DAS. Light irrigation (2-3cm) was given at 37 and 39 DAS in the first and second year respectively. The crop was harvested plot wise on February 16, 2008 for the first year of experiment and on February 15, 2009 for the second year of experimentation, respectively. The data on yield components and seed yield were recorded at harvest. Oil content was estimated using Soxhlet Ether Extraction method. Economic analysis was carried out using the prevailing market price. The available N, P, K and S status at initial stage and after harvest of the crop was estimated by using standard methods. The statistical analysis of data was done following the procedure for analyzing factorial RBD and by using statistical software MSTAT-C version 2.1(Michigan State University, USA). Significant differences between the treatments were compared with the critical difference at $\pm$ 5% probability by LSD.

RESULTS AND DISCUSSION

The results (Table 1) showed significant variation in yield attributing characters and seed yield (Table 2) under various fertility levels used in the integrated nutrient management schedule during both the years of experimentation. The highest values of the characters and components were obtained from the plots receiving 75% RD + FYM +, *Azotobacter* + P.S.B. The plots receiving nutrient only from the inorganic sources produced the lowest values of all the yield attributing characters. It is noticeable that amidst all the fertility treatments, combination of different sources of nutrients helped the yellow sarson plant to perform better than the sole application of chemical fertilizer and that too at recommended dose during both the years of the study. Seed yield of yellow sarson was markedly influenced as a result of application of plant nutrient from different compatible sources through integrated nutrient management schedule. Significantly the highest seed yield (1374 kg ha^{-1}) was recorded wherein 75% of the recommended dose of chemical fertilizers was supplemented with FYM, *Azotobacter* and P.S.B. There was an increase in 38.9 and 40.8% seed yield in the year 2007-08 and 2008-09 respectively in this treatment over inorganic supply of 100% recommended dose. Nutrient management treatment devoid of any organics or bio-fertilizers showed poor effect on productivity of yellow sarson. Stover yield of yellow sarson followed similar trend as that of seed yield. Harvest index of yellow sarson did not differ much due to different fertility levels under integrated nutrient management practice during the study period. It is reported that that one of the important non-symbiotic nitrogen fixing bacteria *Azotobacter* and phosphate solubilizing bacteria can benefit rapeseed-mustard (Anonymous, 2005). Some of P.S.B and *Azotobacter* produce growth hormones *viz.*, IAA and gibberellins and make the soil nutrient in available form (Bais et al., 2006 and Bisht et al., 2009). These hormones play a vital role to stimulate root growth and development with better light interception and greater uptake of nutrients which ultimately enhanced the seed yield. On the other hand, side by side FYM is a good substrate for the bio-fertilizers with a buffering tendency. FYM also increases fertilizer use efficiency, supplies micronutrients and make the phosphate in the soil more available to plants even in slightly acidic soil. All these reasons reflected positively in improving yield and yield components of yellow sarson. In a field experiment Ghosh et al. (2001) also found significantly higher yield attributes with seed inoculation through either of the bacteria, though the magnitude of increase was more with *Azotobacter*. Interaction between K and bio-fertilizers as well as between bio-fertilizers and N were found significant in increasing the yield components and yield of rapeseed.

The number of siliqua $plant^{-1}$, length of siliqua and number of seeds $siliqua^{-1}$ of yellow sarson differed significantly due to the variation in pre-sowing seed soaking agro-chemicals. It was found that soaking the seeds with 100ppm KH_2PO_4 recorded maximum number of siliqua $plant^{-1}$ (99 and 100), length of siliqua (5.6 cm), number of seeds $siliqua^{-1}$ (31.9 and 32.0) and seed yield (1205 and 1226 kg ha^{-1}) during both the years of experimentation. It was closely followed by the seed soaking treatment where the seeds were soaked with 100 ppm Na_2HPO_4. Significantly lower values of all the characters were observed where water soaked seeds were used for sowing. It was also observed that the pre-sowing seed soaking levels used in this study had no significant effect on 1000-seed weight of yellow sarson. Stover yield followed similar trend as in seed yield. Harvest index of yellow sarson did not vary significantly under various seed soaking treatments during both the years of study. Better preservation of cellular substances with sequential changes in the viscosity and elasticity of protoplasm, lower water deficit, increase in water balance and extensive root system of plants are the physiological basis for pre-sowing seed soaking.

ATP is the biological energy needed for every biosynthetic pathways as well as biological work. During germination and early crop establishment, the embryo of a seed not only acts as the source for enzyme substrate but also co-factors for the synthesis of ATP. So soaking of seeds with salts solutions might have a contribution in early active absorption, translocation of plant nutrients accumulated in available form at the soil solution near the root zone of the plants and better photosynthetic activities, which ultimately results in higher, yield attributing characters and yield of the crop. Mondal et al. (2004) reported similar results on *Brassica juncea.*

Significantly the highest oil yield (566 and 584 kg ha^{-1} during I and II year respectively) was obtained in treatment receiving of 75% of the recommended dose along with FYM, *Azotobacter* and P.S.B. it was closely followed by 75% of the recommended dose + FYM+ *Azotobacter* and 75% of the recommended dose + FYM + P.S.B (Table: 2). The lowest oil yield was obtained in the fertility treatment where 100% of the recommended dose was applied. The highest oil content was noticed in 100% RDF + S (41.8%) followed by 75% RD + FYM + S (41.7%) during I year. Increased seed oil content and oil yield of Indian mustard cv. Rh-30 were also obtained by Singh and Singh (2006) with the application of FYM 5 t ha^{-1} along with inorganic fertilizer and bio-fertilizers. No significant effect has been found on oil content of yellow sarson after sowing of soaked seeds either with water or with any agro-chemicals. But oil yield varied significantly with agro-chemicals soaked seeds. As there was significant variation in seed yield under various soaking treatments, accordingly the highest oil yield was obtained in the plots where the seeds were soaked with 100ppm KH_2PO_4 before sowing closely followed by the plots where the seeds were soaked with 100ppm Na_2HPO_4 before sowing. Mondal et al. (2004) also observed improved oil yield of Indian mustard with the pre-sowing seed treatment. During both the years of experimentation no significant variations on seed and oil yield of yellow sarson were observed due to interaction effect between integrated nutrient management practices and seed priming methods.

Highest return/rupee invested was recorded with the integrated nutrient management treatment where 75% of RD, FYM, *Azotobacter* and P.S.B applied together. The returns/rupee invested in these treatments was significantly higher than those plots where either chemical fertilizers or a combination of chemical fertilizers and vermicompost were applied (Table 3). Despite higher initial production cost in these treatments, there was a noticeable return/rupee of investment due to higher magnitude of seed yield. The crop failed to show any remarkable response with additional application of expensive sulphur in the sulphur rich soil (available $SO_4^{=}$ 35.20 kg ha^{-1}) was supposed to be the main reason for poor result. Vermicompost along with 75% of the recommended dose showed better result compared to FYM along with 75% of the recommended dose, but due to higher production cost of vermicompost of investment was not found favourable. Slight increase in cost of cultivation in the seed soaking treatments with agro-chemicals compared to water soaked seeds showed significantly higher return/rupee investment. The highest return/rupee of invested was obtained with the seed soaking with 100 ppm KH_2PO_4 and it was closely followed by the crop raised where seeds were soaked with 100ppm Na_2HPO_4. Higher return/rupee invested was mainly attributed to the higher seed and stover yield of yellow sarson with the pre-sowing seed soaking with either KH_2PO_4 or Na_2HPO_4 compared to the water soaked seeds.

The results (Table 4) also showed a slight build up in available nitrogen, phosphorus and potassium in soil after the harvest of yellow sarson crop due to the use of inorganic fertilizers (75%) in combination with organic manure (25%) and more with integrated use of inorganic fertilizers, organic manure and bio-fertilizers. Slight increase in available nitrogen might be due to addition of N through organic matter, release of N from soil by microbes. Increased root biomass due to integrated nutrient management practices, which remained in the soil after harvesting of crop may also responsible for building up N status. Addition to this important characteristics of *Azotobacter* associated with plant improvement is excretion of ammonia in the rhizosphere in the presence of root exudates (Narula et al., 2009), which could explain why treatment with *Azotobacter* resulted in a slightly higher available N in soil. Mineralization of FYM or solubilization from native source due to PSB contributed build up in available phosphorus in soil. The increased K-level was attributed to increased mineralization due to decomposition of organic manure as well as increased activities of microorganism under integrated nutrient management practices. Some extent of nutrient depletion was noticed after the harvest of yellow sarson in treatment where only inorganic source of nutrients were applied as the source of NPK. As the experimental soil was rich in sulphur, there was not much depletion or increment in sulphur level. However, an amount of increase in available sulphur has been observed in the plots where the yellow sarson crops received 20 kg ha^{-1} sulphur. Accumulation of sulphur in the soil due to external application might be responsible for increased available sulphur on those treatments. There was no such remarkable difference in the fertility status due to pre-sowing seed soaking after harvest of each crop. However, the increased values of available nutrients after second year of experimentation were due to combination effect of treatments with integrated nutrient management practices.

CONCLUSION

Integrated nutrient management and pre-sowing seed soaking showed distinct effect on yellow sarson productivity and economics, a recommendation may come out in combination of both the factors. In this study 75% recommended dose of chemical fertilizer, FYM, *Azotobacter*, P.S.B and sowing of seeds after soaking of seeds in 100ppm KH_2PO_4 came out as the best treatment among the treatment combinations used in the study at the eastern part of Indian Sub-Himalayan plains.

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Table 1. Effect of integrated nutrient management and pre-sowing seed soaking on yield attributing characters of yellow sarson, West Bengal

	2007-08				2008-09			
	No. of siliqua $plant^{-1}$	Length of siliqua (cm)	No. of seeds $siliqua^{-1}$	1000 seed weight (g)	No. of siliqua $plant^{-1}$	Length of siliqua (cm)	No. of seeds $siliqua^{-1}$	1000 seed weight (g)
INM practices								
Recommended Dose	80	4.3	28.0	3.2	83	4.3	27.4	3.2
100%RD+ Sulphur	92	4.4	29.4	3.2	92	4.4	29.4	3.2
75%RD+FYM	93	4.9	29.7	3.2	93	5.0	29.4	3.3
75%RD+Vermicompost	96	5.0	30.9	3.3	96	5.1	31.2	3.3
75%RD+FYM+*Azotobacter*	102	6.0	32.8	3.3	104	6.0	33.2	3.4
75%RD+FYM+P.S.B	100	5.9	33.2	3.3	102	5.9	31.5	3.3
75%RD+FYM+*Azotobacter*+P.S.B	110	6.9	34.6	3.4	113	6.9	35.5	3.4
75%RD+FYM+Sulphur	92	6.3	30.4	3.3	97	6.3	30.8	3.3
S.Em ($\pm$)	2.8	0.17	0.71	0.03	2.72	0.16	0.73	0.03
C.D (P=0.05)	8.1	0.48	2.01	0.09	7.73	0.45	2.07	0.09
Seed Priming Methods								
Water Soaked	91	5.2	30.0	3.3	94	5.3	29.6	3.3
Soaked in 100ppm Na_2HPO_4	97	5.6	31.4	3.3	99	5.6	31.4	3.3
Soaked in 100ppm KH_2PO_4	99	5.6	31.9	3.3	100	5.6	32.0	3.3
S.Em ($\pm$)	1.7	0.10	0.43	0.02	1.6	0.10	0.45	0.02
C.D (P=0.05)	4.9	0.29	1.23	NS	4.7	0.28	1.27	NS
C.V (%)	10.6	10.0	8.0	3.2	9.8	9.2	8.2	3.3

Table 2. Effect of integrated nutrient management and pre-sowing seed soaking on performance of yellow sarson, West Bengal

	2007-08					2008-09					Pooled	
	Seed yield (kg ha^{-1})	Stover yield ($kgha^{-1}$)	Harvest Index (%)	Oil cont. (%)	Oil yield (kg ha^{-1})	Seed Yield (kg ha^{-1})	Stover Yield (kg ha^{-1})	Harvest Index (%)	Oil cont. (%)	Oil yield ($kgha^{-1}$)	Seed yield ($kgha^{-1}$)	Stover yield ($kgha^{-1}$)
INM practices												
Recommended Dose	980	2869	25.4	39.0	383	984	2843	25.7	39.2	386	982	2856
100%RD+ Sulphur	1015	2929	25.7	41.8	426	1010	2994	25.2	42.1	426	1012	2961
75%RD+FYM	1133	3278	25.6	38.6	438	1163	3381	25.6	38.3	446	1148	3329
75%RD+Vermicompost	1183	3413	25.7	39.7	470	1207	3526	25.5	39.2	473	1195	3470
75%RD+FYM+*Azotobacter*	1246	3481	26.3	40.8	510	1294	3820	25.3	40.4	525	1270	3651
75%RD+FYM+P.S.B	1231	3508	25.9	40.8	503	1239	3491	26.0	40.9	507	1235	3499
75%RD+FYM+*Azotobacter*+P.S.B	1361	3812	26.3	41.6	566	1387	3969	25.8	42.1	584	1374	3891
75%RD+FYM+Sulphur	1140	3266	25.8	41.7	475	1164	3400	25.4	42.1	490	1152	3333
S.Em ($\pm$)	50.4	124.5	0.36	0.65	22.9	47.4	129.7	0.26	0.66	20.3	34.6	89.9
C.D (P=0.05)	144	355	NS	1.85	65	135	369	NS	1.88	58	97	253
Seed Priming Methods												
Water Soaked	1091	3142	25.73	40.0	434	1116	3214	25.7	40.4	450	1103	3178
Soaked in 100ppm Na_2HPO_4	1187	3373	26.0	40.7	484	1201	3501	25.5	40.9	493	1194	3437
Soaked in 100ppm KH_2PO_4	1205	3443	25.8	40.8	496	1226	3568	25.5	40.3	496	1216	3506
S.Em ($\pm$)	30.9	76.2	0.22	0.40	14.0	29.0	79.4	0.16	0.40	12.4	21	55
C.D (P=0.05)	88	217	NS	NS	40	83	226	NS	NS	36	60	155
C.V (%)	11.8	9.9	4.27	5.4	13.8	10.5	9.9	3.0	5.7	11.5	12.5	11.3

Table 3. Economics of yellow sarson cultivation as influenced by integrated nutrient management and pre-sowing seed soaking

	2007-08				2008-09			
	Cost of cultivation (INR ha^{-1})	Gross return (INR ha^{-1})	Net return (INR ha^{-1})	Return INR^{-1} of invest-ment	Cost of cultivation (INR ha^{-1})	Gross return (INR ha^{-1})	Net return (INR ha^{-1})	Return INR^{-1} of invest-ment
INM practices								
Recommended Dose	13218	19887	6669	1.50	13518	19964	6446	1.47
100%RD+ Sulphur	14218	20591	6372	1.44	14518	20499	5981	1.40
75%RD+FYM	14660	22979	8319	1.56	14960	23603	8642	1.57
75%RD+Vermicompost	17860	23998	6138	1.34	18160	24489	6329	1.34
75%RD+FYM+*Azotobacter*	14810	25264	10453	1.70	15110	26266	11156	1.73
75%RD+FYM+P.S.B	14810	24973	10163	1.68	15110	25118	10008	1.66
75%RD+FYM+*Azotobacter*+P.S.B	14960	27603	12643	1.84	15260	28144	12883	1.84
75%RD+FYM+Sulphur	15660	23135	7475	1.47	15960	23629	7668	1.48
S.Em (±)		1020	1020	0.066		960	960	0.061
C.D (P=0.05)		2905	2905	0.19		2734	2734	0.17
Seed Priming Methods								
Water Soaked	14992	22134	7142	1.47	15292	22630	7338	1.47
Soaked in 100ppm Na_2HPO_4	15042	24087	9045	1.60	15342	24379	9038	1.58
Soaked in 100ppm KH_2PO_4	15042	24441	9399	1.62	15342	24883	9542	1.62
S.Em (±)		625.2	625.2	0.04		588.2	588.2	0.03
C.D (P=0.05)		1779.4	1779.4	0.1		1674.3	1674.3	0.1
C.V (%)		11.7	32.4	11.6		10.5	29.2	10.4

Market price of yellow sarson seed INR 20 kg^{-1} and stover INR10 $toone^{-1}$

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Table 4. Effect of integrated nutrient management and pre-sowing seed soaking on fertility status after harvest of yellow sarson

	Nitrogen (N kg ha^{-1})		Phosphorus (P_2O_5 kg ha^{-1})		Potassium (K_2O kg ha^{-1})		Sulphur (SO_4 kg ha^{-1})	
INM practices	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
Recommended Dose	213	213	44	44	143	143	32	32
100%RD+ Sulphur	213	214	44	44	143	143	35	35
75%RD+FYM	217	219	47	48	148	149	33	34
75%RD+Vermicompost	218	221	48	48	149	150	33	34
75%RD+FYM+*Azotobacter*	218	224	47	48	148	149	33	34
75%RD+FYM+P.S.B	217	219	48	49	148	149	33	34
75%RD+FYM+*Azotobacter*+P.S.B	219	224	49	49	148	149	33	35
75%RD+FYM+Sulphur	217	219	47	47	147	148	35	35
Seed Priming Methods								
Water Soaked	216	219	47	47	147	148	33	34
Soaked in 100ppm Na_2HPO_4	216	219	47	47	147	148	33	34
Soaked in 100ppm KH_2PO_4	216	219	47	47	147	148	33	34

Initial Value: Available N=216.38 kg ha^{-1}, Available P= 46.52 kg $P_2O_5 ha^{-1}$, Available K=147.45 kg K_2O ha^{-1}, Available S= $SO_4^{=}$35.20 kg ha^{-1}