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# Yield performances and soil fertility status in *Brassica rapa* var. yellow sarson - *Vigna radiata* L. sequence as influenced by INM and seed priming in preceding crop

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***Abstract:*** *A field experiment was conducted during* rabi *2007-08 to 2008-09 to study the effect of different nutrient management practices and pre-sowing seed soaking on yellow sarson* (Brassica rapa *var.* yellow sarson) *- greengram* (Vigna radiata *L.*) *crop sequence. The experiment was laid out in factorial randomized block design with twenty four treatment combinations and replicated thrice. The treatments were allotted to yellow sarson and its residual effect was studied in greengram. Seed yield of yellow sarson increased markedly due to the integrated nutrient management consisting 75% of the recommended dose (recommended dose-60:30:30 N:$P_2O_5$:$K_2O$ kg $ha^{-1}$), FYM (5 t $ha^{-1}$),* Azotobacter *(5 kg $ha^{-1}$) and P.S.B (5 kg $ha^{-1}$). This nutrient management practice also had greater impact in sustenance in soil fertility and enrichment of soil nutrients, which ultimately reflected in terms of yield performances of succeeding greengram. This practice came out as remunerative one under yellow sarson - greengram sequence. The crop receiving plant nutrients only from chemical sources showed poor growth and productivity leading to less remuneration. Pre-sowing soaking of seeds with 100ppm $KH_2PO_4$ also showed improvement in the productivity of yellow sarson crop compared to seeds soaked with 100ppm $Na_2HPO_4$ and water, but no significant variation in productivity of greengram was found due to seed soaking treatments on preceding crop. Increased net return and return $INR^{-1}$ invested have been observed in yellow sarson- greengram sequence where the yellow sarson seeds were soaked with 100ppm $KH_2PO_4$ over the other soaking treatments. No such variations in residual fertility have been observed due to seed priming.*

***Key words:*** *economics; greengram; INM; residual fertility; seed priming; yellow sarson;*

## INTRODUCTION

Rapeseed-mustard (*Brassica spp.*)-greengram (*Vigna radiata* L.) is a common crop sequence in West Bengal, an eastern state of India as well as in the sub-Himalayan plains which is situated at the northern fringe of the state that is in the foot hills of Himalaya, known as *terai* region. Though rapeseed-mustard is the major oilseed of this region, the productivity is very poor (491 kg $ha^{-1}$) compared to the state average productivity (899 kg $ha^{-1}$). The poor productivity might be due to the imbalanced fertilization that too in sub-optimal dose and lack of use of organic matter (Bourguignon, 2005). Sometimes poor rather uneven crop establishment resulting less productivity of yellow sarson (Islam *et al.*, 2013).

With almost twice the quantity of plant nutrients being removed from the soil than what is added through fertilizers, the growing plant nutrient imbalance poses a major threat to sustain soil health and crop productivity in India. Under the circumstances, integrated approach of nutrient supply by chemical fertilizer along with organic manures and bio-fertilizers is gaining importance as the system not only reduces the use of inorganic but also acts as an environment friendly approach. Again, pre-sowing seed priming not only homogenizes a seed lot, but this practice also gives a good, uniform 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 a seed an earlier and increased germination, better and uniform field establishment. Growing of a legume crop after

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rapeseed-mustard may help in restoration of soil fertility. Sustaining the crop productivity for a long time is a challenging problem in some crop sequences where rotation includes a crop with high nutrient mining. However, inclusion of greengram, a short duration pulse, in the rotation may provide a viable option for sustaining crop production. Under the circumstances, an experiment was undertaken to asses the effect of INM and pre-soaking seed treatment on yellow sarson-greengram sequence.

## MATERIALS AND METHODS

The field experiment was conducted at Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India during two consecutive years, *viz*., 2007-08 and 2008-09. The farm is situated at $26^0$19′86" N latitude and $89^0$23′53" E longitude and at an altitude of 43 meter above mean sea level. The experimental soil was slightly acidic in reaction (pH-6.14), sandy loam in texture having mineralizable N 216.38 kg $ha^{-1}$, available $P_2O_5$ 46.52 kg $ha^{-1}$, available $K_2O$ 147.45 kg $ha^{-1}$and available $SO_4^=$ 35.20 kg $ha^{-1}$.

The experiment was laid out in factorial randomized block design with twenty four treatment combinations in plot size of 4m x 3m and replicated thrice. The treatments comprised of the combination of different fertility levels based on integrated nutrient management practices ($F_1$=60:30:30 kg $ha^{-1}$ of N-$P_2O_5$ -$K_2O$ as recommended Dose; $F_2$=100% Recommended Dose + Sulphur 20 kg $ha^{-1}$; $F_3$=75% Recommended Dose + 5t $ha^{-1}$ FYM; $F_4$=75% Recommended Dose + 5 t $ha^{-1}$ vermicompost; $F_5$=75% Recommended Dose + 5 t $ha^{-1}$ FYM + *Azotobacter*; $F_6$= 75% Recommended Dose + 5 t $ha^{-1}$ FYM + P.S.B; $F_7$= 75% Recommended Dose +5 t $ha^{-1}$ FYM+ *Azotobacter* + P.S.B; $F_8$=75% Recommended Dose + 5 t $ha^{-1}$ FYM+ Sulphur 20 kg $ha^{-1}$) and different seed priming levels with water and agro-chemicals ($P_0$= water priming; $P_1$= pre-sowing seed priming with 100ppm $Na_2HPO_4$; $P_2$= pre-sowing seed priming with 100ppm $KH_2PO_4$) before sowing.

The treatments were applied to yellow sarson only and their residual effect was studied on greengram, the succeeding crop on the same lay-out. In treatment combination under study, the organic manures were 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. Side by side these fertility treatments were subjected to various soaking chemicals ($Na_2HPO_4$ and $KH_2PO_4$) including water and the performances were assessed accordingly. 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. 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 per cent 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 yellow sarson variety NC-1, popularly known as *Jhumka*, was sown at 30 cm rows apart on November 03 and October 31 during 2007-08 and 2008-09 ;while greengram variety Pant Moong 2 was sown at 30 cm rows apart on February 20 and 16 during the first and second year of experimentation, respectively. The data on seed and stover yield for both the crops were recorded at harvest. Economic analyses were carried out using the prevailing market price. The statistical analysis of data was done following the procedure for analyzing factorial RBD (Cochran and Cox, 1977) 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 ± 5% probability by LSD. The representative soil samples were analyzed for ascertaining the available nutrients in soil at initial stage and after harvest of each crop following standard methods.

## RESULTS AND DISCUSSION

The significant highest seed yield of yellow sarson (1374 kg $ha^{-1}$) was obtained from the plots where the crops received the nutrients in a combination of inorganic, organic and bio-fertilizers *i.e.*, 75% of the recommended dose of chemical fertilizers along with FYM, *Azotobacter* and P.S.B (Table 1). Nutrient management treatment devoid of any organics or bio-fertilizers showed poor effect on crop yields. One of the important non-symbiotic nitrogen fixing bacteria *Azotobacter* and Phosphate Solubilizing Bacteria (P.S.B) beside fixing ambient nitrogen to the soil and solubilize phosphates in the soil, can benefit rapeseed-mustard by producing growth hormones, viz., IAA and gibberellins also. These hormones might have played a vital role in greater uptake of nutrients by efficient photosynthetic activities. Side by side FYM is a good substrate for the bio-fertilizers and with a buffering tendency, FYM also increases fertilizer use efficiency applied in inorganic form to the crop, supplies micronutrients and makes the phosphate in the soil more available to plants even in slightly acidic soil. De *et al.* (2013) also found better yield of yellow sarson with the application of INM in comparison to sole application of chemical fertilizer in foot hills of Himalaya. Again, an increase in seed yield (1216 kg $ha^{-1}$) was noticed in plots where yellow sarson seeds were soaked with 100ppm $KH_2PO_4$ before sowing during both the years of the experimentation and it was closely followed by the soaking treatment where the seeds were soaked with 100ppm $Na_2HPO_4$ (1194 kg $ha^{-1}$). ATP is the biological energy needed for every biosynthetic pathways as well as biological work. During 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 the pre-sowing seed soaking with phosphorus containing salts 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 with light interception resulting higher growth attributes and yield components as well as higher seed and stick yield of yellow sarson. This was in conformity with the results found by Paul *et al.* (1999). Similar results were also found by Mondal *et al.* (2004) in field study to evaluate the effect of pre-sowing seed treatment with water and different agro-chemicals in *Brassica juncea.*

The residual effect of integrated nutrient management significantly increased the seed yield as well as biomass yield of greengram, the succeeding crop in the rotation (Table 1). Application of FYM, *Azotobacter* and PSB in combination with 75% of recommended dose to yellow sarson only registered the highest seed yield (629 kg $ha^{-1}$) ,which was 26.40% higher than the yield recorded with 100% recommended dose. This was statistically *at par* with the yield obtained under the treatment receiving 75% RD with FYM and PSB. Nawale *et al.* (2009) reported yield maximization in chickpea through INM applied to preceding sorghum. The trend was also similar in biomass yield as well as harvest indices where combination of organics, bio-fertilizers and inorganic resulted in higher values. The results indicated a profound influence of residual effect of organic manures along with bio-fertilizers on greengram productivity. The results are in close conformity with the findings of Maiti *et al.* (2005). Kumpawat (2010) also reported the beneficial residual effect of integrated nutrient management on succeeding crop in blackgram - mustard sequence. However, it was revealed that the seed yield as well as biomass yield did not differ significantly with residual effect of various pre-soaking seed treatment applied to yellow sarson for both the years under experimentation.

Highest return $INR^{-1}$ investment (2.16) in yellow sarson-greengram sequence was recorded with the integrated nutrient management treatment where 75% of the recommended dose of chemical fertilizers, FYM, *Azotobacter* and P.S.B applied together. The crop failed to show any remarkable response with additional application of expensive sulphur (Table 2). Presence of adequate sulphur in the eastern sub-Himalayan *terai* soil was supposed to be the main reason for this 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, the treatment failed to show any promising result in terms of return $INR^{-1}$ of investment in the eastern Indian sub-Himalayan plains. Slight increase in cost of cultivation in the seed soaking treatments with agro-chemicals compared to water soaked seeds showed higher return $INR^{-1}$ invested in yellow sarson-greengram sequence. The highest returns $INR^{-1}$ of investment (1.93 and 1.92) were obtained with the seed soaking with 100ppm $KH_2PO_4$ before sowing.

Results clearly indicated an increase in available nitrogen in experimental soil after completion of two year crop sequence in treatments receiving 75% of the recommended dose of chemical fertilizers, FYM, *Azotobacter* and P.S.B. Initial N (216.38 kg $ha^{-1}$) increased to 222.56 kg $ha^{-1}$ after first year of rotation which further increased to 227.39 kg $ha^{-1}$after second year rotation (Table 3). It was followed by the treatment comprising 75% of the recommended dose of chemical fertilizers, FYM and *Azotobacter.* This might be due to addition of N through organic matter and 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. It has also been reported that *Azotobacter* not only provides nitrogen, but also produces a variety of growth-promoting substances (Bisht *et al.,* 2009) like IAA, gibberellins and B vitamins (Bais *et al.,* 2006). These substances stimulate, at least to some degree, the production of root exudates. Addition to this, another 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

**Table 1**
**Effect of Integrated nutrient management and seed-soaking agro-chemicals on seed yield, stick yield and harvest index of *B.rapa* var. yellow sarson and *Vigna radiata* L.**

(Pooled data of two years)

| *Fertility Levels* | *Yellow sarson* | | | *Greengram* | | |
|---|---|---|---|---|---|---|
| | *Seed yield (kg ha$^{-1}$)* | *Stick yield (kg ha$^{-1}$)* | *Harvest Index (%)* | *Seed Yield (kg ha$^{-1}$)* | *Biomass Yield (kg ha$^{-1}$)* | *Harvest Index (%)* |
| Recommended Dose | 982 | 2856 | 25.60 | 568 | 3186 | 17.85 |
| 100%RD+ Sulphur | 1012 | 2961 | 25.48 | 593 | 3322 | 17.87 |
| 75%RD+FYM | 1148 | 3329 | 25.62 | 620 | 3460 | 17.94 |
| 75%RD+Vermicompost | 1195 | 3470 | 25.66 | 671 | 3727 | 18.06 |
| 75%RD+FYM+*Azotobacter* | 1270 | 3651 | 25.83 | 664 | 3708 | 17.96 |
| 75%RD+FYM+P.S.B | 1235 | 3499 | 25.99 | 686 | 3774 | 18.20 |
| 75%RD+FYM+*Azotobacter*+P.S.B | 1374 | 3891 | 26.09 | 718 | 3904 | 18.41 |
| 75%RD+FYM+Sulphur | 1152 | 3333 | 25.63 | 629 | 3526 | 17.89 |
| S.Em (±) | 34.63 | 89.93 | 0.31 | 13.95 | 77.29 | 0.26 |
| C.D (P=0.05) | 97 | 253 | NS | 39 | 217 | NS |
| Pre-sowing seed soaking | | | | | | |
| Water Soaked | 1103 | 3178 | 25.72 | 639 | 3539 | 18.05 |
| Soaked in 100ppm $Na_2HPO_4$ | 1194 | 3437 | 25.77 | 640 | 3553 | 18.06 |
| Soaked in 100ppm $KH_2PO_4$ | 1216 | 3506 | 25.81 | 652 | 3635 | 18.06 |
| S.Em (±) | 21 | 55 | 0.19 | 8.54 | 47.33 | 0.16 |
| C.D (P=0.05) | 60 | 155 | NS | NS | NS | NS |

**Table 2**
**Economics of cultivation under *B.rapa* var yellow sarson – *Vigna radiata* sequence as influenced by integrated nutrient management and seed-soaking agro chemicals**

| *Fertility Levels* | *2007-08* | | | | *2008-09* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Cost of cultivation (INR ha$^{-1}$)* | *Gross return (INR ha$^{-1}$)* | *Net return (INR ha$^{-1}$)* | *Return per INR investment* | *Cost of cultivation (INR ha$^{-1}$)* | *Gross return (INR ha$^{-1}$)* | *Net return (INR ha$^{-1}$)* | *Return per INR investment* |
| Recommended Dose | 20873 | 37097 | 16224 | 1.78 | 21473 | 36828 | 15354 | 1.71 |
| 100%RD+ Sulphur | 21873 | 38564 | 16691 | 1.76 | 22473 | 38089 | 15616 | 1.69 |
| 75%RD+FYM | 22315 | 41529 | 19214 | 1.86 | 22915 | 42253 | 19337 | 1.84 |
| 75%RD+Vermicompost | 25515 | 43635 | 18120 | 1.71 | 26115 | 45099 | 18984 | 1.73 |
| 75%RD+FYM+*Azotobacter* | 22465 | 44914 | 22448 | 2.00 | 23065 | 46453 | 23388 | 2.01 |
| 75%RD+FYM+P.S.B | 22465 | 45317 | 22851 | 2.02 | 23065 | 45958 | 22893 | 1.99 |
| 75%RD+FYM+*Azotobacter*+P.S.B | 22615 | 48770 | 26155 | 2.16 | 23215 | 50060 | 26845 | 2.16 |
| 75%RD+FYM+Sulphur | 23315 | 41739 | 18423 | 1.79 | 23915 | 42769 | 18853 | 1.79 |
| Pre-sowing seed soaking | | | | | | | | |
| Water Soaked | 22647 | 41063 | 18417 | 1.81 | 23247 | 42016 | 18770 | 1.81 |
| Soaked in 100ppm $Na_2HPO_4$ | 22697 | 43189 | 20493 | 1.91 | 23297 | 43674 | 20378 | 1.88 |
| Soaked in 100ppm $KH_2PO_4$ | 22697 | 43834 | 21138 | 1.93 | 23297 | 44626 | 21329 | 1.92 |

why treatment with *Azotobacter* resulted in a slightly higher available N in soil. Inclusion of a legume in the rotation further contributed towards nitrogen enrichment in soil.

The treatments comprising sole application of chemical fertilizers brought about a decrease in soil nitrogen status after yellow sarson which improved a bit with inclusion of greengram in the sequence. The maximum increase in available phosphorus in soil was noticed when yellow sarson received 75% of the recommended dose along with FYM, *Azotobacter* and P.S.B. closely followed by the plots where the crop received 75% of the recommended dose along with FYM and P.S.B. Mineralization of FYM or solubilization from native source due to PSB contributed build up. The results were indicative of a profound influence of residual effect of organic manures along with bio-fertilizers. A considerable increase in potassium level in the soil was observed where yellow sarson crop received vermicompost along with 75% recommended dose through inorganic fertilizers (Table 4). A little bit of depletion in available potassium has been observed in treatments where the crop received NPK from only the inorganic sources. 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 crop received 20 kg $ha^{-1}$sulphur (Table 4). Accumulation of sulphur in the soil due to external application might be responsible for increased available sulphur on those treatments. It was interesting to observe that even the yellow sarson is an exhaustive crop with regard to sulphur, the organic matters and bio-fertilizers helped to sustain the sulphur level in experimental soil. It was revealed that cultivation of greengram after yellow sarson with an integration of different nutrient sources comprising inorganic and organic sources as well as bio-fertilizers were beneficial to sustain soil health.

**Table 3**
**Effect of Integrated nutrient management and seed-soaking agro-chemicals on nitrogen and phosphorus status after harvest of each crop in the sequence**

| *Fertility Levels* | *Nitrogen (kg $ha^{-1}$)* | | | | *Phosphorus ($P_2O_5$ kg $ha^{-1}$)* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Yellow sarson (1 st crop)* | *Green gram (2 ndcrop)* | *Yellow sarson (3 rd crop)* | *Green gram (4 th crop)* | *Yellow sarson (1 st crop)* | *Green gram (2 nd crop)* | *Yellow sarson (3 rd crop)* | *Green gram (4 th crop)* |
| Recommended Dose | 213.16 | 214.93 | 213.18 | 214.56 | 44.16 | 44.06 | 44.32 | 44.12 |
| 100%RD+ Sulphur | 213.25 | 215.12 | 214.25 | 214.92 | 44.25 | 44.18 | 44.36 | 44.25 |
| 75%RD+FYM | 217.92 | 219.36 | 219.93 | 221.76 | 47.12 | 47.93 | 48.72 | 48.96 |
| 75%RD+Vermicompost | 218.16 | 220.43 | 221.18 | 223.98 | 48.23 | 48.40 | 48.96 | 49.18 |
| 75%RD+FYM+*Azotobacter* | 218.85 | 221.18 | 224.38 | 226.12 | 47.93 | 47.62 | 48.13 | 48.92 |
| 75%RD+FYM+P.S.B | 217.17 | 218.98 | 219.32 | 221.59 | 48.92 | 49.46 | 49.85 | 50.16 |
| 75%RD+FYM+*Azotobacter*+P.S.B | 219.30 | 222.56 | 224.16 | 227.39 | 49.13 | 49.56 | 49.92 | 50.93 |
| 75%RD+FYM+Sulphur | 217.69 | 218.92 | 219.38 | 221.36 | 47.21 | 47.12 | 47.92 | 48.25 |
| Pre-sowing seed soaking | | | | | | | | |
| Water Soaked | 216.88 | 218.89 | 219.41 | 221.40 | 47.04 | 47.24 | 47.74 | 48.08 |
| Soaked in 100ppm $Na_2HPO_4$ | 216.96 | 218.92 | 219.43 | 221.48 | 47.10 | 47.20 | 47.71 | 48.04 |
| Soaked in 100ppm $KH_2PO_4$ | 216.98 | 219.01 | 219.57 | 221.54 | 47.22 | 47.33 | 47.86 | 48.18 |

Initial Value: Available N=216.38 kg $ha^{-1}$, Available P= 46.52 kg $P_2O_5$ $ha^{-1}$

**Table 4**
**Effect of Integrated nutrient management and seed-soaking agro-chemicals on potassium and sulphur status after harvest of each crop in the sequence**

| *Fertility Levels* | *Potassium (kg $K_2O$ $ha^{-1}$)* | | | | *Sulphur (kg $SO_4^{=}$ $ha^{-1}$)* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Yellow sarson (1 st crop)* | *Green gram (2 nd crop)* | *Yellow sarson (3 rd crop)* | *Green gram (4 th crop)* | *Yellow sarson (1 st crop)* | *Green gram (2 nd crop)* | *Yellow sarson (3 rd crop)* | *Green gram (4 th crop)* |
| Recommended Dose | 143.43 | 143.13 | 143.46 | 143.06 | 32.16 | 33.36 | 32.25 | 33.86 |
| 100%RD+ Sulphur | 143.92 | 143.25 | 143.97 | 143.57 | 35.15 | 36.27 | 35.36 | 37.10 |
| 75%RD+FYM | 148.13 | 148.96 | 149.38 | 149.98 | 33.16 | 34.87 | 34.18 | 35.26 |
| 75%RD+Vermicompost | 149.15 | 149.75 | 150.35 | 150.76 | 33.25 | 34.96 | 34.23 | 35.47 |
| 75%RD+FYM+*Azotobacter* | 148.15 | 148.68 | 149.12 | 149.37 | 33.39 | 35.01 | 34.28 | 35.28 |
| 75%RD+FYM+P.S.B | 148.65 | 149.13 | 149.66 | 149.97 | 33.45 | 34.82 | 34.46 | 35.25 |
| 75%RD+FYM+*Azotobacter*+P.S.B | 148.79 | 149.25 | 149.78 | 149.96 | 33.56 | 35.45 | 35.18 | 35.92 |
| 75%RD+FYM+Sulphur | 147.96 | 148.46 | 148.92 | 149.13 | 35.65 | 36.90 | 35.98 | 37.25 |
| Pre-sowing seed soaking | | | | | | | | |
| Water Soaked | 147.21 | 147.53 | 148.17 | 148.17 | 33.56 | 35.30 | 34.47 | 35.61 |
| Soaked in 100ppm $Na_2HPO_4$ | 147.35 | 147.67 | 148.01 | 148.32 | 33.70 | 35.16 | 34.57 | 35.76 |
| Soaked in 100ppm $KH_2PO_4$ | 147.25 | 147.54 | 148.06 | 148.20 | 33.90 | 35.17 | 34.43 | 35.64 |

Initial Value: Available K=147.45 $K_2O$ kg $ha^{-1}$ and Available S=35.20 kg $SO_4^{=}$ $ha^{-1}$

## CONCLUSION

A transparent tendency of soil enrichment through these integrated nutrient management practices along with a legume crop may stabilize the soil fertility through the long term trial as there was a direct addition of nutrients to soil reserve through compatible integration. There was no such remarkable difference in the fertility status due to pre-sowing seed priming after harvest of each crop. Thus marked improvement in soil fertility status under *Brassica rapa* var. yellow sarson - *Vigna radiata L.* crop sequence could be achieved with INM schedule consisting 75% of the recommended dose, FYM, *Azotobacter* and P.S.B in yellow sarson, the preceding crop.

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