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Effect of integrated nutrient management on yield, nutrient uptake and economics of rapeseed (*Brassica campestris* var. yellow sarson) in *terai* region of West Bengal

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ABSTRACT

A field experiment was conducted in the experimental farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal during 2007, 2008 and 2009 to study the effect of integrated nutrient management on yield, uptake and economics of Rapeseed (Brassica campestris var. yellow sarson). Based on pooled data treatment T_{11} (50% RDF + FYM @ 2.5 t ha^{-1} + VC @1.25 t ha^{-1} + NC @ 1.25 t ha^{-1} + PM @ 1.25 t ha^{-1}) recorded highest grain yield of 13.48 q ha^{-1} which was statistically at par with T_9 (T_1+ Neemcake @ 2.5 t ha-1) and T_8(T_1+ Vermicompost @ 2.5 t ha^{-1}) (13.40 q ha^{-1}). However, T_1 (100 % RDF+ Borax @ 10.0 Kg ha^{-1}) fetched highest B: C ratio.

Keywords: INM, rapeseed, nutrient uptake, yield

Indiscriminate use of chemical fertilizers for the supply of major nutrients and declining use of secondary nutrients and organic sources of inputs over time led to the deficiency of secondary and micronutrient. Particularly, secondary essential micro-nutrients such as boron and zinc are emerging as one of the major constraints for sustainable production in rainfed areas. Rapeseed-mustard is the major crop under oilseeds but the average yield of it in most of the areas in West Bengal is still extremely low when compared to that of other parts of the country. Rapeseed-mustard is one of the most important edible oilseed crops of the Indo-Gangetic plains but the reasons for low rapeseed-mustard yield are the use of low yield potential varieties, poor soil fertility and nutrient management practices. Nutrient management is the key technology in maintaining and sustaining the production potential of rapeseed-mustard. Continuous use of only chemical fertilizer in intensive cropping system is leading to imbalance of nutrients in soil, which has an adverse effect on soil health and also on crop yields. Furthermore, it is estimated that currently the consumption of chemical fertilizers in the country exceeds the production. Moreover, due to decontrol and escalation of the prices of phosphate (P) and potassium (K) fertilizers, the farmers are using much less than the optimum levels of these two nutrients (currently the N:P:K: ratio is 9.5:3.2:1 against earlier ratio of 5.4:2.4:1). The use of these sub-optimal doses of nutrients by the farmers has also led to severe depletion of nutrient reserves of the soil resulting in multiple nutrient deficiencies. These factors together suggest a need for reduced consumption of chemical fertilizers and increase use of organic manure, crop residues and biofertilizers (De and Sinha, 2011). On the other hand, continuous use of organics helps to build up soil humus and beneficial microbes besides improving the soil physical properties. Therefore, a substitution and/or supplementation of major nutrients with a considerable proportion from organic manures for sustaining higher yield, is of urgent necessity (De *et al.,* 2009).

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MATERIALS AND METHODS

The experiment was carried out at Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India during the winter season of 2007, 2008 and 2009 respectively. The farm is situated at 26° 19' 86" N latitude and 89° 23' 53" E longitude and at an altitude of 43 meters above mean sea level. The soil of the experimental site was sandy loam (62-65% sand, 18% silt, 16- 17% clay) in texture, with 5.2 g organic carbon/kg soil and acidic in nature (pH of 5.42), low in available nitrogen (118 kg ha^{-1}), medium in available phosphorus (24 kg ha^{-1}) and low in available potash (76 kg ha^{-1}). The experiment was laid out on 25th, 17th and 20th day of October in 2007, 2008 and 2009 and harvested on 14th, 24th and 12th day of March in 2008, 2009 and 2010 respectively. The experiment was laid out in a randomized block design with 12 treatments viz. 100% Recommended Dose of Fertilizer (RDF) 60:30:30 kg ha^{-1} of N: P: K (T_1), 100% RDF + Borax @ 10.0 kg ha^{-1} (T_2), FYM @ 10.0 t ha^{-1} (T_3), Vermicompost @ 5.0 t ha^{-1} (T_4), Neemcake @ 5.0 t ha^{-1} (T_5), Poultry manure @ 5.0 t ha^{-1} (T_6), T_1+ FYM @ 5.0 t ha^{-1} (T_7), T_1+ Vermicompost (VC) @ 2.5 t ha^{-1} (T_8), T_1+ Neemcake (NC) @ 2.5 t ha^{-1} (T_9), T_1+ Poultry manure (PM) @ 2.5 t ha^{-1} (T_{10}), 50% RDF+ FYM @ 2.5 t ha^{-1} + VC @1.25 t ha^{-1} + NC @ 1.25 t ha^{-1} + PM @ 1.25 t ha^{-1} (T_{11}) and Control (T_{12}) and replicated thrice. Well decomposed farmyard manure, vermicompost, neemcake, poultry manure with nitrogen, phosphorus and potassium in the form of urea, SSP, MOP and borax were applied to the soil as per treatments. Full dose of phosphorus, potash and half of the recommended dose of nitrogen and borax were applied as basal dose. Rest half of the recommended dose of nitrogen was applied as top dressing at 21 DAS (days after sowing) after completion of the first weeding. One irrigation was given to rapeseed crop at 45 DAS. Rapeseed cultivar "NC- 1" was sown at a spacing of 30 cm × 10 cm. Nitrogen content of the plant parts were analyzed separately after harvest by modified Kjeldahl method (Jackson. 1967) and was multiplied by their respective dry weights to work out uptake of nutrients of different parts as well as the plant as a whole and represented by the standard units. The N, P and K content of farm yard manure (0.43, 0.16 and 0.44%), vermicompost (0.75, 0.26 and 0.03%), poultry manure (2.13, 1.11 and 1.09%) and neemcake (1.73, 0.66 and 0.94%) were analyzed following standard procedure. The data collected from the field and laboratory experiments were subjected to statistical analysis and the treatment variations were tested for significance (Gomez and Gomez, 1984) at 5% level.

RESULTS AND DISCUSSION

Yield

The seed yield of rapeseed was significantly influenced by different integrated nutrient management (INM) treatments during three years of experiment. The interaction effect is highly significant at 5% level of significance. Among the organics, the pooled value of Vermicompost @ 5.0 t ha^{-1} (T_4) recorded highest seed yield (10.19 q ha^{-1}) which was statistically at par with Neemcake @ 5.0 t ha^{-1} (T_5) due to higher dry matter accumulation (Fig.-1). In the pooled data, the highest seed yield was recorded under T_{11} (50% Recommended dose + FYM @ 2.5 t ha^{-1} + Vermicompost @1.25 t ha^{-1} + Neemcake @ 1.25 t ha^{-1} + Poultry manure @ 1.25 t ha^{-1}) followed by T_9 (100% of recommended dose + Neemcake @ 2.5 t ha^{-1}) and T_8 (100 % of recommended dose + Vermicompost @ 2.5 t ha^{-1}), which was indicative of the fact that during the three years of experiment, Neemcake, Vermicompost and Poultry manure in conjunction with FYM, nitrogen, phosphorus, potassium exhibited their role in various physiological functions, movement of growth regulators within the plant, germination and growth of pollen grains and pollen tubes (De and Sinha, 2012). Again, T_{11}, T_9 and T_8 showed 77.8, 76.7 and 74.5% increase in yield over absolute control (T_{12}) respectively. These results confirm the findings of Abrol *et al.* (2007) & Subhash and Ram (2007).

Uptake

Significant variation in N and P uptake by seed and stover of rapeseed was noticed under different nutrient management treatments (Fig 2). Integrated use of organic and inorganic sources of nutrients significantly improved the N and P uptake by seed and stover over 100% recommended dose of fertilizer (60:30:30 kg ha^{-1} of N: P: K) (T_1). Difference between the treatments receiving sole organics such as, T_3, T_4, T_5 & T_6 and combined application of organic and inorganics such as, T_{11} and T_9 remained non significant in case of N uptake by seed. In the pooled data (Fig. 2), the highest N uptake by seed (64.13 kg ha^{-1}) and stover (103.64 kg ha^{-1}) was recorded from the treatments consisting of 50% Recommended dose with FYM and Vermicompost, Neemcake & Poultry manure @ 2.5 t ha^{-1} and 1.25 t ha^{-1} respectively. This was due to higher nitrogen content in stover and higher seed and stover yields at these treatment combinations applied to rapeseed. The highest P uptake from seed and stover was recorded from treatments consisting of T_{11} followed by T_9 respectively. Treatments T_{11}, T_9 and T_8

Table 1: ANOVA results for effects of year and treatment on measured variables from rapeseed.

	Yield			Uptake		
Source	**Seed yield**	**Stover yield**	**Harvest index**	**Nitrogen**	**Phosphorus**	**Potassium**
Year (Y)	***	***	***	***	**	***
Treatment (T)	***	***	***	**	***	***
Interaction Y x T	***	***	***	***	***	***
SEm(±)	**0.01**	**0.02**	**0.01**	**0.03**	**0.03**	**0.09**
LSD(0.05)	**0.02**	**0.06**	**0.02**	**0.08**	**0.08**	**0.25**

* significant at $P \leq 0.05$, ** significant at $P \leq 0.05$ or $P \leq 0.03$, *** significant at $P \leq 0.05$ $P \leq 0.03$ or $P \leq 0.01$

were at par in case of seed and stover respectively. This was due to slightly higher phosphorus content in both seeds and stover and largely due to higher seed and stover yield of rapeseed at these treatment combinations over the three years. The uptake of potassium was highest at T_{11} through seed and stover of rapeseed, which increased due to adequate supply of nutrients. It might be due to increased growth, nutrient influx and photosynthetic rate which resulted in more absorption and translocation of these nutrients to the seed and stover. Again, it was supposed to be boron, zinc as well as sulphur favored fruit-setting and grain filling of rapeseed by improving the source-sink relationships and photosynthate partitioning (De and Sinha, 2012). The results are in confirmatory with Srivastava and Pathak, 1980; Tomar *et al.,* (1990) & Mandal and Sinha (2004).

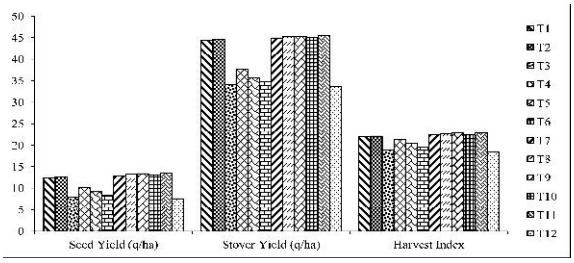

Fig. 1: Seed, stover yield and harvest index of rape seed.

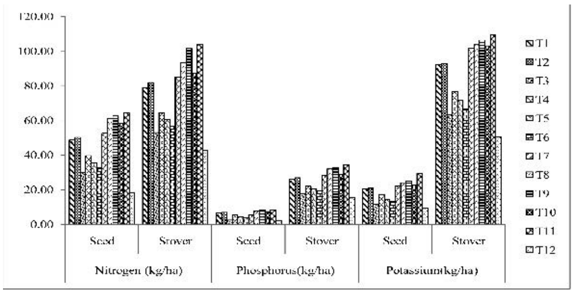

Fig. 2: NPK uptake of rapeseed (Pooled of three years).

Economics

The total net return was higher at the treatment combinations receiving 100% of recommended dose of N, P_2O_5 & K_2O than the treatments receiving sole application of organics. This indicated that the crop had received the most congenial nutrient status in soil for the fullest manifestation of its vegetative and reproductive organs of rapeseed when these treatments were applied. Consequently, total net return was increased. Among the treatment combinations, in the pooled data for three years, the maximum higher net return of Rs 40440/- accrued to T_{11}. The minimum pooled total net return of three years was obtained at T_9 (100% of RD + Neemcake @ 2.5 t ha^{-1}). Higher price of neemcake (Rs 10/Kg) leads to increased treatment cost of Rs 50,000 (5 t ha^{-1}) in turn

Table 2: Economics of rapeseed crop as influenced by different integrated nutrient management treatments (Pooled of three years).

Treatments	Total cost (Rs ha^{-1})	Seed yield (q ha^{-1})	#Total investment (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	Benefit cost ratio
T_1	1554	124.70	12527	37410	24883	1.99
T_2	3954	126.50	14927	37950	23023	1.54
T_3	3700	79.70	14673	23910	9237	0.63
T_4	17500	101.90	28473	30570	2097	0.07
T_5	50000	91.60	60973	27480	-33493	-0.55
T_6	30000	84.30	40973	25290	-15683	-0.38
T_7	3404	129.20	14377	38760	24383	1.70
T_8	10304	132.30	21277	39690	18413	0.87
T_9	26554	134.00	37527	40200	2673	0.07
T_{10}	16554	130.90	27527	39270	11743	0.43
T_{11}	15452	134.80	26425	40440	14015	0.53
T_{12}	_	75.80	10973	22740	11767	1.07

T_1= 100% Recommended dose (60:30:30 Kg ha^{-1} of N: P_2O_5: K_2O); T_2= 100% Recommended dose + Borax @ 7.5 Kg ha^{-1}; T_3= FYM @ 10.0 t ha^{-1}; T_4= Vermicompost @ 5.0 t ha^{-1}; T_5= Neemcake @ 5.0 t ha^{-1}; T_6= Poultry manure @ 5.0 t ha^{-1}; T_7= T_1+ FYM @ 5.0 t ha^{-1}; T_8= T_1+ Vermicompost @ 2.5 t ha^{-1}; T_9= T_1+ Neemcake @ 2.5 t ha^{-1}; T_{10}= T_1+ Poultry manure @ 2.5 t ha^{-1}; T_{11}= 50% Recommended dose + FYM @ 2.5 t ha^{-1} + VC @1.25 t ha^{-1} + NC @ 1.25 t ha^{-1} + PM @ 1.25 t ha^{-1}; T_{12}= Control.

** Rs 300/- per quintal of seed Cost of cultivation = Rs 10973/- # Total investment = Cost of cultivation + treatment cost*

**Farm Yard Manure: Rs. 925 t^{-1}, *Poultry Manure: Rs. 6 Kg^{-1} *Vermicompost: Rs. 3.5 Kg^{-1}, *Borax (Powdered): Rs. 300 Kg^{-1}.*

**Neemcake: Rs. 10 Kg^{-1} *All the prices are averages for the period of 2007, 2008 and 2009.*

elevating the investment cost of Rs 60973 ha^{-1}, where as the pooled net return showed a loss of Rs 33493. Net monetary return with higher net return rupee^{-1} investment at T_1, T_7 and T_2 showed a high paying potential of rapeseed cultivation. The results are corroborative of the findings of Ali and Basu (1992) and Dubey and Khan (1993).

Combination of all the organic sources with inorganic nutrients reveals that higher yield as well as uptake by rapeseed are recorded in addition with the improvement in soil health but recommendations could only be made by judging from the economic point of view where treatment consisting of 100% recommended fertilizer along with Borax showed higher benefit due to lower cost. Thus, farmers who produce or recycle their own organic sources for their field application could only be benefited in the long run.

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