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Impact of combined exposure of chemical, fertilizer, bio-fertilizer and compost on growth, physiology and productivity of *Brassica campestries* in old alluvial soil

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Abstract: *Field experiment was carried out during November 2006 to February 2007 under old alluvial soil to evaluate the impact of combined dose of chemical fertilizer, biofertilizer in combination with compost for the yellow sarson (Brassica campestries cv.B_9) in a randomized block design replicated thrice. Various morpho-physiological parameters viz., plant population, length of shoot and root, leaf area index (LAI) , crop growth rate (CGR), net assimilation rate (NAR) , yield attributes viz., number of siliquae per plant, number of seeds / siliquae, 1000 seed weight (test weight), seed yield , stover yield and physiological and biochemical parameters viz., pigment content, sugar, amino acid, protein, ascorbic acid content in physiologically active leaf were performed. The treatment T_1 i.e., 40% less N fertilizer, 25% less P fertilizer, K fertilizer constant + 12 kg ha^{-1} biofertilizer (Azophos) and organic manure (compost) @ 5Mt ha^{-1}, showed the maximum chlorophyll accumulation (10.231 mg g^{-1} freshweight), highest seed /siliquae (25.143), test weight of seeds (4.861g) and highest seed yield (10.661 tha^{-1}). A comparison between all the morphological, anatomical, physiological and biochemical parameters due to application of chemical fertilizer, bio-fertilizer and compost alone and in combination and their impact on soil microorganism, flora and fauna will throw a sound environmental information.*

Key words: *Yellow sarson, Brassica campestries, Yield attributes, Morphophysiological parameters*
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Introduction

Mustard is an important oil seed crop in India being next to groundnut. Mustard seed has got 35-40% protein content with higher nutritive value. Chemical fertilizers have contributed significantly towards the pollution of water, air and soil. So the current trend is to explore the possibility of supplementing chemical fertilizers with organic ones which are ecofriendly and cost effective . Higher seed and stover yield with highest level of organic matter enrichment along with biofertilizers was reported by Chaudhury and Kabi (2003). Similar findings were reported by Nanda, (2003), Sinha (2003) and Chaturvedi *et al.* (2008). According to a field experiment conducted by Chand *et al.* (2006) it was found that integrated supply of plant nutrients through FYM (farmyard manure) and fertilizer NPK, along with *Sesbania* green manuring, played a significant role in sustaining soil fertility and crop productivity. Mahapatra *et al*. (2007) reported average increase of 6.15 fibre yield of jute with application of NPK along with farmyard manure. According to Das and Saha (2007) inoculation of *Azotobacter* and *Azospirillum* in presence of partial application of fertilizer-N and farmyard manure yielded less grain, by 12.7 and 8.3% and less straw yield by 10.6 and 17.1% respectively, while the combined inoculation of the diazotrophs increase grain and straw yields by 4.5 and 5.85 respectively than the optimum yields recorded in the soil treated with 100 kg Nha^{-1} only. Several works have been reported towards the increase in the yield with individual application of chemical fertilizers as well as biofertilizer and compost. In the present investigation the effect of 40% reduced level of nitrogen fertilizer and 25% reduce level of phosphate fertilizer plus recommended dose of potash fertilizer along with biofertilizer *Azophos* and organic manure on physico-chemical character of soil, length of shoot and root, crop growth analysis, yield attributes of yellow sarson (*Brassica campestries* cv.B_9) were studied. Therefore, our objective of this current study was to asses the impact of combined exposure of chemical fertilizer, biofertilizer and compost in relation to seed yield of yellow sarson (*Brassica campestries* cv.B_9) as well as screening of best combined dose of biofertilizer, chemical fertilizer and compost of mustard cultivation in terms of yield and productivity under this agroclimatic conditions of old alluvial soil zone of Burdwan.

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Materials and Methods

A field experiment was conducted during November2006 to February 2007 at field crop research station (FCRS), Burdwan, West Bengal, India. The Experiment was conducted in randomized block design with three replications and five treatments . Individual plot size was 5 m x 3 m .Treatments were T_1- 40% less 'N' fertilizer, 25% less 'P' fertilizer, 'K' fertilizer (recommended dose) + 12 kg ha^{-1} biofertilizer (*Azophos*) and organic manure (compost) @ 5Mt ha^{-1}, T_2- 40% less 'N' fertilizer, 25% less 'P' fertilizer, 'K' fertilizer (recommended dose)+ 12 kg ha^{-1} biofertilizer (*Azophos*) and organic manure (compost) @ 7.5 Mt ha^{-1}, T_3- 40% less 'N' fertilizer, 25% less 'P' fertilizer, 'K' fertilizer (recommended dose)+ 12 kg ha^{-1} biofertilizer (*Azophos*) and organic manure (compost) @ 10 Mt ha^{-1},T_4- 40% less 'N' fertilizer, 25% less 'P' fertilizer, 'K' fertilizer (recommended dose)+ 12 kg ha^{-1} biofertilizer (*Azophos*) and organic manure (compost) @ 12.5Mt ha^{-1}, T_5- 40% less 'N' fertilizer, 25% less 'P' fertilizer, 'K' fertilizer (recommended dose) + no application organic manure (control). The recommended dose for mustard crop in West Bengal is 100:50:50. Weekly minimum and maximum

temperature and total rainfall , sunshine hours, atmospheric pressure and relative humidity(RH) was recorded. At various stages of crop growth plant population, leaf area index (LAI), crop growth rate (CGR) and net assimilation rate (NAR), were estimated by following the methods of Watson (1950). Fifteen sample data were used for statistical analysis of the field data.To analyze the tabulated data as observed in the field experiment and laboratory analysis in different aspects Coehran and Cox (1959), Fisher (1960), Panse and Sukhatme (1967), Gomez and Gomez (1984) were consulted. For interpreting the effect of different treatments under different cases, for comparison of F-values and at 5% level of significance, Fisher and Yates table (1953) were followed. For estimation of physiological and biochemical parameters the method of Arnon (1949) for chlorophyll content (mg g^{-1} freshweight), Mc Cready (1950) for sugar content (mg 100 g^{-1}), Lowry *et al.* (1951) for protein content (mg 100 g^{-1}), Moore and Stain (1948) for amino acid content (mg 100 g^{-1}), Mukherjee and Chaudhuri (1983) for ascorbic acid content (mg 100 g^{-1}) were followed.

Results and Discussion

In the present investigation the minimum and maximum temperature varied between 9.5-20°C and 24.5 to 33.5°C and amount of total rainfall was 15.8 mm during the entire cropping period (Table 1). The soil results revealed that pH was slightly alkaline in nature in soil after treatment with compost than the soil before sowing. Again the available nitrogen,available phosphate, available potassium, organic carbon content increased in soil after combined exposure of chemical fertilizer, biofertilizer and compost treatment with respect to soil before combined exposure of chemical fertilizer, biofertilizer and compost treatment. The level of soil macronutrients increased in all the treatment with respect to the control (Table 2). Subsequently the effect of 40% reduced level of nitrogen fertilizer and 25% reduce level of phosphate fertilizer plus recommended dose of potash fertilizer along with biofertilizer *Azophos* and organic manure on physico-chemical character of soil, length of shoot and root, crop growth analysis, yield attributes of yellow sarson (*Brassica campestries* cv.B_9) were studied. From the experimental results maximum plant population / m^2 was observed in T_1 treatment (Table 3).The statistical analysis showed significant difference among the different treatments under this agro – climatic condition. The length of shoot and root was recorded on 70 DAS (days after sowing). Among the treatments, treatment T_5 showed highest shoot length and also the LAI value was recorded on 30,50,70 DAS. The maximum value of LAI on 30 DAS and 50 DAS was recorded from T_5 treatment but on 70 DAS from T_1. In all the cases data was statistically significant at 5% level of significance. Results at 5% level of significance suggests that there were significant variation of LAI values due to differential growth rates of crop plants under five different treatments under this agro-climatic zone of Burdwan district. Results of other morpho-physiological parameters like CGR, NAR have been presented in (Table 4). All the values were recorded in two phases, one between 30-50DAS and the other between 50-70 DAS. The CGR is a simple and important index of agriculture productivity on rate of dry matter production. The highest CGR value was observed in case of treatment T_5 in between 30-50 DAS and in treatment T_1 in between 50-70 DAS. NAR is related to photosynthetic activities of leaf *i.e.*, rate of increase in dry weight of whole plant / unit leaf area. In both the stages of crop growth, crop growth rate was found significant at 5% level of significance where as in case of NAR the value was non significant at the first phase and was significant in the 2nd stages of growth. From the statistical analysis it can be concluded that combined exposure of chemical fertilizer, biofertilizer and compost have significantly contributed towards the crop morphophysiological parameters *viz.*, LAI,CGR, NAR thus contributing towards the

Table - 1: Climatological details (week wise) during the period of experiment

Month	Standard (weeks)	Mean temperature (°C) Max	Min	RH (%)	Mean atmospheric pressure (Millibar)	Mean sunshine (hr)	Rainfall (mm)
Nov 2006	1st	27	14.2	68.65	1010.41	7.62	0
	2nd	26.5	14.5	62.45	1015.26	6.94	0
	3rd	26.4	14.1	69.79	1009.05	7.89	0
	4th	27.1	12.3	71.47	1006.06	8.05	0
Dec 2006	5th	27.0	12.5	37.0	1017.39	6.89	0
	6th	26.0	13.0	35.0	1016.16	6.96	0
	7th	25.5	13.5	41.0	1014.24	7.24	0
	8th	24.5	14.0	56.0	1014.36	7.69	15.8
	9th	25.5	11.8	37.0	1016.18	8.02	0
Jan 2007	10th	25.0	11.2	38.0	1020.37	7.12	0
	11th	25.6	9.5	29.0	1018.16	7.46	0
	12th	29.0	13.2	28.0	1016.18	7.93	0
	13th	24.5	10.7	31.0	1014.36	8.02	0
	14th	27.0	11.0	31.0	1009.16	8.12	0
Feb 2007	15th	28.4	14.7	35.0	1011.11	8.16	0
	16th	30.0	16.4	32.0	1012.26	8.42	0
	17th	33.5	20.0	34.0	1011.46	8.58	0

RH = Relative humidity

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Table - 2: Chemical properties of alluvial soil before sowing (BS) and after harvesting

Treatments	pH	Organic carbon (%)	Available phosphate (kg ha^{-1})	Available potash (kg ha^{-1})	Available nitrogen (kg ha^{-1})
BS	5.11	0.217	111.09	20.940	200.861
T_1	6.15	0.392	145.491	11.378	240.244
T_2	6.24	0.579	133.995	10.001	268.162
T_3	6.29	0.200	159.009	14.978	252.515
T_4	6.15	0.638	158.148	12.355	326.176
T_5	6.18	0.412	47.479	12.915	272.864
SEM (±)	0.051	0.063	3.932	0.959	22.241
CD (5%)	0.154	0.191	11.925	2.908	67.461
CV (%)	3.751	61.83	1.575	7.115	1.813

SEM =Standard error mean, CD (5%) = Critical difference at 5%, CV = Covariance

Table - 3: Plant population, length of shoot and root and leaf area index (LAI) under various treatments (T_1-T_5)

Treatments	No. of plants m^{-2}	Shoot length 70 DAS (cm)	Root length 70 DAS (cm)	Leaf area index (LAI)		
				30 DAS	50 DAS	70 DAS
T_1	172.051	85.161	12.874	1.228	1.456	1.703
T_2	165.24	83.633	13.532	0.741	1.205	1.305
T_3	155.46	81.247	12.901	0.932	0.772	0.944
T_4	148.35	83.025	11.955	1.366	1.389	1.622
T_5	124.56	86.241	13.191	1.672	2.560	1.201
SEM(±)	3.201	2.108	0.778	0.218	0.318	0.182
CD(5%)	3.368	6.393	2.359	0.661	0.964	0.552
CV(%)	1.168	1.731	6.873	39.507	38.205	31.484

SEM = Standard error mean, CD (5%) = Critical difference at 5%, CV = Covariance, DAS = Days after sowing, T_1-T_5 = Treatments

Table - 4: Crop growth rate (CGR), Net assimilation rate (NAR) under various treatments (T_1-T_5)

Treatments	CGR (gm^{-2} days^{-1})		NAR (gm^{-2} days^{-1})	
	30-50 DAS	50-70 DAS	30-50 DAS	50-70 DAS
T_1	0.173	1.371	0.050	0.051
T_2	0.388	0.885	0.200	0.061
T_3	0.299	0.848	0.011	0.052
T_4	0.276	1.144	0.030	0.042
T_5	0.447	1.056	0.029	0.022
SEM (±)	0.001	0.001	0.006	0.0006
CD (5%)	0.003	0.003	0.020	0.001
CV (%)	13.231	2.834	121.03	53.716

CGR = Crop growth rate, NAR = Net assimilation rate, DAS = Days after Sowing, SEM = Standard error mean, CD (5%) = Critical difference at 5%, CV= Covariance

Table - 5: Length of siliquae, number of seeds per siliquae, test weight, grain yield and straw yield under various treatments (T_1-T_5)

Treatments	Length of siliquae (cm)	No. of seeds / siliquae	Test weight (g)	Seed yield (t.ha^{-1})	Straw yield (t.ha^{-1})
T_1	5.621	25.143	4.861	10.661	12.245
T_2	5.384	24.134	4.764	9.332	11.161
T_3	5.161	22.355	4.585	7.524	8.892
T_4	4.897	21.455	4.122	6.661	7.882
T_5	4.864	20.832	4.024	4.925	5.661
SEM (±)	0.534	3.289	0.678	2.202	0.711
CD (5%)	0.580	3.414	1.551	2.794	1.587
CV (%)	14.093	7.960	18.429	18.940	13.741

SEM = Standard error mean, CD (5%) = Critical difference at 5%, CV = Covariance

Table - 6: Chlorophyll, sugar, amino acid, protein, ascorbic acid content in physiologically active leaf at 50 DAS under various treatments (T_1-T_5)

Treatments	Chlorophyll (mg g^{-1} freshweight)			Sugar (mg 100 g^{-1})	Amino acid (mg 100 g^{-1})	Protein (mg 100 g^{-1})	Ascorbic acid (mg 100 g^{-1})
	Chl-'a'	Chl-'b'	Tot Chl				
T_1	8.324	1.451	10.231	0.174	0.832	12.611	0.906
T_2	7.944	1.372	9.691	0.210	0.640	16.875	1.552
T_3	4.291	0.871	5.045	0.223	0.640	20.174	1.171
T_4	3.937	1.164	4.756	0.080	0.512	19.182	0.824
T_5	3.012	0.555	3.532	0.092	0.668	36.351	0.791
SEM (±)	2.591	0.065	0.021	0.021	0.064	0.924	0.181
CD (5%)	3.030	0.479	0.274	0.274	0.495	1.809	0.802
CV (%)	29.259	23.643	2.134	93.413	40.006	5.389	40.565

SEM = Standard error mean, CD (5%) = Critical difference at 5%, CV = Covariance, Chl-a = Chlorophyll-a, Chl-b = Chlorophyll-b, Tot Chl = Total Chlorophyll

vegetative growth of plant body. Appropriate nutrient managment treatments through combined exposure of biofertilizer, chemical fertilizer and compost (T_1-T_5)have significantly increased the photosynthetic rate,which have increased the dry matter accumulation leading towards increasing value of CGR and NAR as was reported by (Mandal and Sinha, 2004) Estimated results of other parameters such as length of siliquae(cm), No. of seeds / siliquae , test weight (g), seed yield (t.ha^{-1}) and straw yield (t.ha^{-1}), have been represented in (Table 5). Both length of siliquae and number of seeds / siliquae were recorded maximum in treatment T_1 there by indicating positive correlation between the two parameters. Highest test weight was recorded in treatment T_1 and minimum in treatment T_5. Regarding straw yield, seed yield maximum values were observed in case of treatment T_1 . The data on plant population / m^2 correlates with straw yield . Estimated data of length of siliquae, No. of seeds / siliquae , test weight (g), seed yield were statistically non significant but straw yield were statistically significant for all the treatments at 1% level of

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significance. Lower productivity might be attributed to poor partitioning of dry matter to flowers and pods at flowering stage (50 DAS), mid flowering stage (55 DAS) and active pod-filling (70 DAS) stages.Therefore, there was inefficient turnover of photoassimilates into ultimate sink formation in these stages as reported by (Majumdar *et al.,* 2004). The data on the level of chlorophyll (chlorophyll-a, chlorophyll-b and total chlorophyll), sugar, amino acid, protein ascorbic acid are shown in (Table 6). From the tabulated data it appeared that maximum accumulation of chlorophyll-a, chlorophyll-b and total chlorophyll were recorded from treatment T_1. Maximum accumulation of sugar content in physiologically active leaf was found to be in case of treatment T_1 which was supported by highest seed yield in this treatment. This is due to the fact that due to higher biosynthesis of chlorophyll and photosynthesis of flag leaf of plants under treatment T_1 maximum translocation of photosynthate from flag leaf to the seeds occurred under this treatment which was similarly reported by El –Sherbeny *et al.* (2005) on *Sideritis montana* and Ali (2005) on iris that application of compost pronouncedly improved carbohydrates in leaf. The other biochemical constituents such as amino acids, protein, ascorbic acids also showed significant difference among the various treatments. Our findings corroborates with the findings of Mona *et al*. (2006) that application of biofertilizer along with compost pronouncedly improved chlorophyll content and yield attributes *viz.*, No. of seeds/siliquae,seed yield, straw yield.Increase in yield attributes *i.e.*, higher yield and fruit number/ plant in *Capscicum annum* and *Lawsonia inermis* when FYM and/or *Azotobacter* was used was similarly reported by Atta-alla *et al.* (2005), Attia and Abdel-Azeem (2005). From the results it was found that from 5 Mt ha^{-1} onwards upto 12.5 Mt ha^{-1} the application of compost played no significant role in increasing the yield which may be due to lack of proper nutrition due to slow release of nutrient from the soil with gradual increase of compost application as reported by Siraj *et al.* (2001), From this study, it may be concluded that the best treatment seems to be T_1 (*i.e.*, 40% less 'N' fertilizer, 25% less' 'P' fertilizer, 'K' fertilizer (recommended dose) + 12 kg ha^{-1} biofertilizer (*Azophos*) and organic manure (compost) @ 5 Mt/ha) under this agroclimatic zone of old alluvial soil thereby indicating the potentiality of application of organic manure in increasing yield along with sustainable soil health.

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