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Screening of Mustard Varieties under Combined Dose of Fertilizers and Subsequent Soil Health and Biodiversity in Old Alluvial Soil of Burdwan, West Bengal, India

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Abstract: Field experiment was carried out with five selected mustard cultivars during November 2007 to February 2008 under old alluvial soil in the Crop Research and seed Multiplication Farm of Burdwan University, Burdwan, West Bengal, India in randomized block design replicated thrice. Various growth parameters viz., length of shoot and root, number of primary branches per plant, length of siliquae, diameter of siliquae; morpho-physiological parameters viz., Leaf area index (LAI), Leaf Area Duration(LAD),Crop Growth Rate(CGR); yield attributesviz., number of grains per siliquae, test weight of grains, total grain yield, total straw yield; photosynthetic pigment content in physiologically active leaf were performed. The variety Ragini(V_4) recorded a significant higher seed yield along with other growth, yield and morphophysiological factors, which was found to be superior to other varieties under old alluvial soil zone of Burdwan, West Bengal, India. The impact of combined doses of fertilizers on soil health were also evaluated.

Key words: Mustard · Growth · Yield · Morpho-physiological parameters

INTRODUCTION

The introduction of a superior variety may accomplish the same objectives as the evaluation of a superior variety through breeding programs. Newly introduced variety may excel the out dated local variety in terms of increased yield per unit area. Similarly, fertilizers play an important role in the environmental influences on crop production. Research workers have reported differential responses of different genotypes to fertilizer application [1]. Several factors responsible for low yield are poor soil, out dated varieties and lack of modern technologies used for cropping. The application of suitable fertilizers in appropriate doses is considered as one of the most important factors for increasing crop yield per unit area.

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 some earlier works [2]. Average increase of fibre yield of jute with application of NPK along with farmyard manure [3].

Chemical fertilizers have contributed significantly toward the pollution of water, air and soil. Therefore, the current trend is to explore the possibility of supplementing chemical fertilizers with organic ones that are eco-friendly and cost effective.

Several works have been reported towards the increase in the yield with individual application of chemical fertilizers as well as compost. In the present investigation the effect of combined application of chemical fertilizer and compost on chemical and biological properties of soil,, length of shoot and root, crop growth analysis, yield attributes of five selected mustard cultivars were studied. Therefore, our objective of this current study was to assess the impact of chemical fertilizer and compost in relation to seed yield of five selected mustard cultivars under this agro climatic conditions of old alluvial soil zone of Burdwan.

MATERIALS AND METHODS

A field experiment was carried out with five selected mustard cultivars during November 2007 to February 2008 under old alluvial soil in the Crop Research and seed Multiplication Farm of Burdwan University, Burdwan,

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West Bengal, India. The experiment was conducted in randomized block design with three replications and five varieties. Crop varieties viz., V_1-WBBN-1, V_2-NC-1, V_3-YST-151, V_4-Ragini and V_5-B_9 were collected from the Crop Research and seed multiplication farm, Burdwan University,West Bengal, India. Individual plot size were 5m×3m. Chemical fertilizer were applied @ N:P:K =100:50:50(Recommended dose of Directorate of Agriculture, Government of West Bengal, India). The rate of application of chemical fertilizer in the field includes ½ of the recommended dose of N fertilizer+ full recommended dose of phosphate fertilizer + ½ recommended dose of potassium fertilizer as basal, rest of the part of recommended N and P fertilizer were applied as top dressing 35 days after sowing. Organic manure in the form of compost were applied basally in the form of soil application @7.5 mt.ha^{-1}

Plant samples were collected at intervals of 25 d after sowing from three randomly selected locations in each plot up to the 75 d of crop growth. Ten plant samples were uprooted randomly from each plot under different treatments to determine the growth attributes (root and shoot length, primary branches per plant, secondary branches per plant) and yield attributes (length of siliquae, number of siliquae per plant, number of seeds per siliquae, 1000-seed weight and oil content). Similarly, 10 plants from each plot were randomly selected. The length of shoots was recorded from the base above the ground to the tip of the stem using a scale and the root length was recorded by uprooting the plants from the soil with great care in order to avoid any tear-out of roots and then measured using the scale from the base stem up to the highest length of tap root. Total numbers of primary and secondary branches were counted from 10 randomly selected plants. The height of the 10 plants was recorded by measuring from the ground level to the tip of plants. The total number of filled siliqua per plant was recorded at harvest, while the total number of seeds per siliqua was recorded by random selection of 10 siliquae from each plant per plot at harvest. Thousand seed weight was recorded in grams (g). The seed grain yield of each 1 m×1 m plot segmented from the 5 m×5 m plot was recorded by harvesting plants, followed by sun-drying, threshing and cleaning on the threshing floor. The seed yield was recorded in kg.ha^{-1}. The total weight of harvested plants after sun-drying and before threshing was recorded in order to obtain the stover yields by deducting the seed weight.

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 standard methods [4].

For estimation of photosynthetic pigment content total chlorophyll content (mg.g^{-1}fw) standard methods were followed. [5]. For determination of soil parameters viz., soil pH [6]; Soil Organic carbon(%)[7], available nitrogen [8], Available phosphorous [9] and available potassium [10] standard methods were followed. For soil microbiological studies standard methods were followed. [11].

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 standard methods were followed. [12-15] 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 [16] were followed.

RESULTS AND DISCUSSION

In the present investigation, the soil results revealed that pH was acidic in nature in soil both before and after treatment with compost, but the overall pH value increased in soil samples after compost application than before sowing. Again the available nitrogen, available phosphate, available potassium, organic carbon content decreased in soil after combined exposure of chemical fertilizer and compost with respect to soil before combined fertilizer treatment.. The level of soil macronutrients decreased in all the varietal plots (Table 1) which may be attributed towards the higher rate of uptake of essential macronutrients from soil by the five different mustard cultivars leading to higher growth, yield and productivity.

The length of shoot and root was recorded on 75DAS (days after sowing). Among the varieties, variety V_4 (Ragini) showed higher shoot and root length. (Table 2) From the experimental results, the significant variations in the root and shoot length of the five cultivated mustard varieties may be attributed towards the differential growth rate of the varieties under different assimilative capacity of photosynthate and variable rate of translocation rate in different parts of plant [17]. The number of primary and secondary branches per plant showed significant variation among the different varieties of mustard. The highest and lowest number of primary branches and secondary branches were recorded by V_4(Ragini) and V_1(WBBN-1) (Table 3). The variation in the number of primary and secondary branches per plant reflected the differential rate of vegetative growth among the seven cultivated mustard varieties. This difference in the number of primary branches per plant was due to the genetic potential of the varieties, which might contribute toward the final yields.

Table 1: Chemical characteristics of soil under combined application of chemical fertilizer and compost

Parameters	Variety pH	Before sowing (Fallow land)
	5.55	
	After harvesting	
	V_1	5.56
	V_2	5.58
	V_3	5.61
	V_4	5.62
	V_5	5.60
Organic Carbon(%)	Before sowing (Fallow land)	
	0.490	
	After harvesting	
	V_1	0.50
	V_2	0.50
	V_3	0.495
	V_4	0.510
	V_5	0.515
Available nitrogen (kg.ha^{-1})	Before sowing (Fallow land)	
	278.40	
	After harvesting	
	V_1	260.20
	V_2	253.60
	V_3	254.20
	V_4	246.50
	V_5	251.00
Available Phosphorous (kg.ha^{-1})	Before sowing (Fallow land)	
	242.50	
	After harvesting	
	V_1	216.50
	V_2	212.40
	V_3	226.50
	V_4	219.70
	V_5	220.00
Available Potash (kg.ha^{-1})	Before sowing (Fallow land)	
	246.0	
	After harvesting	
	V_1	229.70
	V_2	234.40
	V_3	240
	V_4	217
	V_5	230.60

Table 2: Growth attributes of five mustard varieties under combined application of chemical fertilizer and compost

	Length of Shoot (cm)			Length of Root (cm)		
Variety	25DAS	50DAS	75DAS	25DAS	50DAS	75DAS
V_1	5.160	9.773	11.866	2.833	10.500	11.300
V_2	5.940	11.133	12.866	3.066	11.700	12.533
V_3	6.026	11.866	13.333	3.166	11.900	13.000
V_4	6.066	12.000	13.300	3.533	13.033	13.900
V_5	6.033	11.933	13.433	3.200	11.800	13.800
SEM (±)	2.155	7.337	8.624	1.902	7.712	8.589
CD(5%)	7.024	23.965	28.168	5.767	25.190	28.054
CV(%)	8.371	7.961	7.553	43.649	7.853	7.568

SEM= standard error mean; CD= Critical diference; CV= covariance

Table 3: Yield attributes of five mustard varieties under combined application of chemical fertilizer and compost

Variety	Pri branches Per plant	Sec Branches per plant	Length Of Siliquae (cm)	Diameter Of Siliquae (cm)	No. of Grains Per siliquae	Test Weight Of grains	Total seed yield (kg.ha^{-1})	Total straw yield (kg.ha^{-1})
V_1	5.233	3.100	24.666	0.853	22.866	3.020	322.333	4395.333
V_2	6.066	4.300	38.000	0.930	26.233	3.086	841.666	6126.333
V_3	5.900	4.966	40.666	0.940	25.860	3.086	828.33	5961.333
V_4	6.486	5.000	42.000	0.970	26.966	3.123	923.000	6628.667
V_5	5.966	4.486	37.000	0.946	25.933	3.060	751.000	6047.000
SEM (±)	2.292	2.703	26.163	0.571	18.104	1.879	529.79	4213.456
CD(5%)	7.486	6.875	85.547	3.160	59.133	5.732	1730.47	13762.579
CV(%)	8.508	36.788	4.675	80.881	5.546	44.579	9557.205	0.371

SEM= standard error mean; CD= Critical diference; CV= covariance

These results were in agreement with some earlier works [18]. The results regarding the number of secondary branches per plant revealed that the said trait was highly significantly affected by different varieties of mustard. Our results were corroborated with some earlier works [19].

From the current investigation, it was observed that there were considerable variations in the yield attributes and yields of the five mustard varieties. The highest and lowest length of siliquae, diameter of siliquae were found to be in case of V_4 and V_1 variety respectively. (Table 3). In the present investigation, due to optimum moisture level for Ragini variety helped to produce longer and thicker siliquae [20].

The variation between the varieties was generated by the relationship between the number of seed per siliquae and seed in one hand and plant potential for increasing siliquae or seed number on the other, as reported earlier [21]. Regarding1000-seed weight, there was also a considerable variation among the varieties.(Table 3) This was probably due to the compensatory relation between yield components, as in cultivars with low grain yield, the number of pod and seed per pod was low and available assimilates partitioned between lower number of seeds and each seed received more assimilate in comparison with high yield cultivars. Some earlier works [22] reported the seed size depended on environmental conditions, genotype and the potential of the genotype in producing seed number. It seemed that the genotype had minor effects on seed weight in comparison with environment.

The LAI (leaf area index) value were recorded on 25,50 and 75 DAS. The maximum LAI value in all the three phases of crop growth were shown by variety V_4(Ragini) (Table 5). Results suggest that there is significant variation of LAI value due to differential growth rates of crop plants under combined exposure of chemical fertilizer and compost., under this agro-climatic zone of Burdwan [23]. Results of other morpho-physiological parameters like LAD(leaf area duration) , CGR(Crop growth rate) have been presented in table. All the values were recorded in two phases, one between 25-50 DAS, and the other between 50-75 DAS. The LAD is a measure of the ability of the plant to produce and maintain leaf area and its whole opportunity for assimilation. The highest LAD values were recorded in case of variety V_4 both at two phases of crop growth. (Table 5).

From the results, it was observed that that there is significant level of variation in the LAD values which may be attributed towards the variable assimilation rate among the different varieties.

The CGR is a simple and important index of agriculture productivity on rate of dry matter production. The highest CGR value were observed in case of variety V_4 in both phases of crop growth. (Table 5) Optimum crop growth rate is achieved when the LAI is large to intercept 95% of the sun's light Greater light interception stimulates CGR which in turn increases total dry matter and LAI. Greater LAI causes higher light interception which further enhances CGR and thus results in higher yield. In the present investigation, the LAI value was higher for variety V_4 which stimulated the vegetative growth leading to higher dry matter accumulation.[24]. From the experimental results it can be concluded that combined exposure of chemical fertilizer and compost have significantly contributed towards the crop morphophysiological parameters viz., LAI, LAD, CGR. thus contributing towards the vegetative growth of plant body Judicious management of nutrient through combined exposure of chemical fertilizer and compost have significantly increased the photosynthetic rate which have increased the dry matter accumulation leading towards increased value of CGR [25]. From the tabulated data it appeared that maximum accumulation of total chlorophyll was found to be maximum in variety V_4, which may be due to higher biosynthesis of chlorophyll and photosynthesis of flag leaf of plants [26] (Table 4).

Table 4: Photosynthetic pignent content of five mustard varieties under combined application of chemical fertilizer and compost

	Total chlorophyll content (mg.g.fw)		
Variety	25DAS	50DAS	75DAS
V_1	0.792	2.077	1.311
V_2	0.832	2.295	1.364
V_3	0.706	2.389	1.547
V_4	0.734	2.230	1.550
V_5	0.760	2.262	1.452
SEM (±)	0.469	1.381	0.877
CD(5%)	2.865	4.914	3.916
CV(%)	89.584	52.222	64.818

SEM= standard error mean; CD= Critical diference; CV= covariance

Table 5: Morphophysiological attributes of five mustard varieties under combined application of chemical fertilizer and compost

	Leaf area index (LAI)			Leaf Area Duration (LAD) (Days)		Crop Growth rate (CGR) g.m^{-2}.day	
Variety	25DAS	50DAS	75DAS	25-50 DAS	50-75 DAS	25-50 DAS	50-75 DAS
V_1	0.240	0.483	0.246	9.040	9.125	7.093	8.226
V_2	0.270	0.533	0.260	10.290	10.166	7.406	12.110
V_3	0.260	0.556	0.256	10.208	10.166	7.566	12.386
V_4	0.270	0.586	0.266	10.708	10.666	7.726	12.986
V_5	0.250	0.533	0.240	9.791	9.666	7.390	12.046
SEM (±)	0.155	0.327	0.155	6.249	6.209	3.955	7.698
CD(5%)	1.649	2.391	1.646	20.411	20.280	12.918	25.144
CV(%)	152.825	105.846	155.189	8.326	8.340	8.910	8.006

SEM= standard error mean; CD= Critical diference; CV= covariance

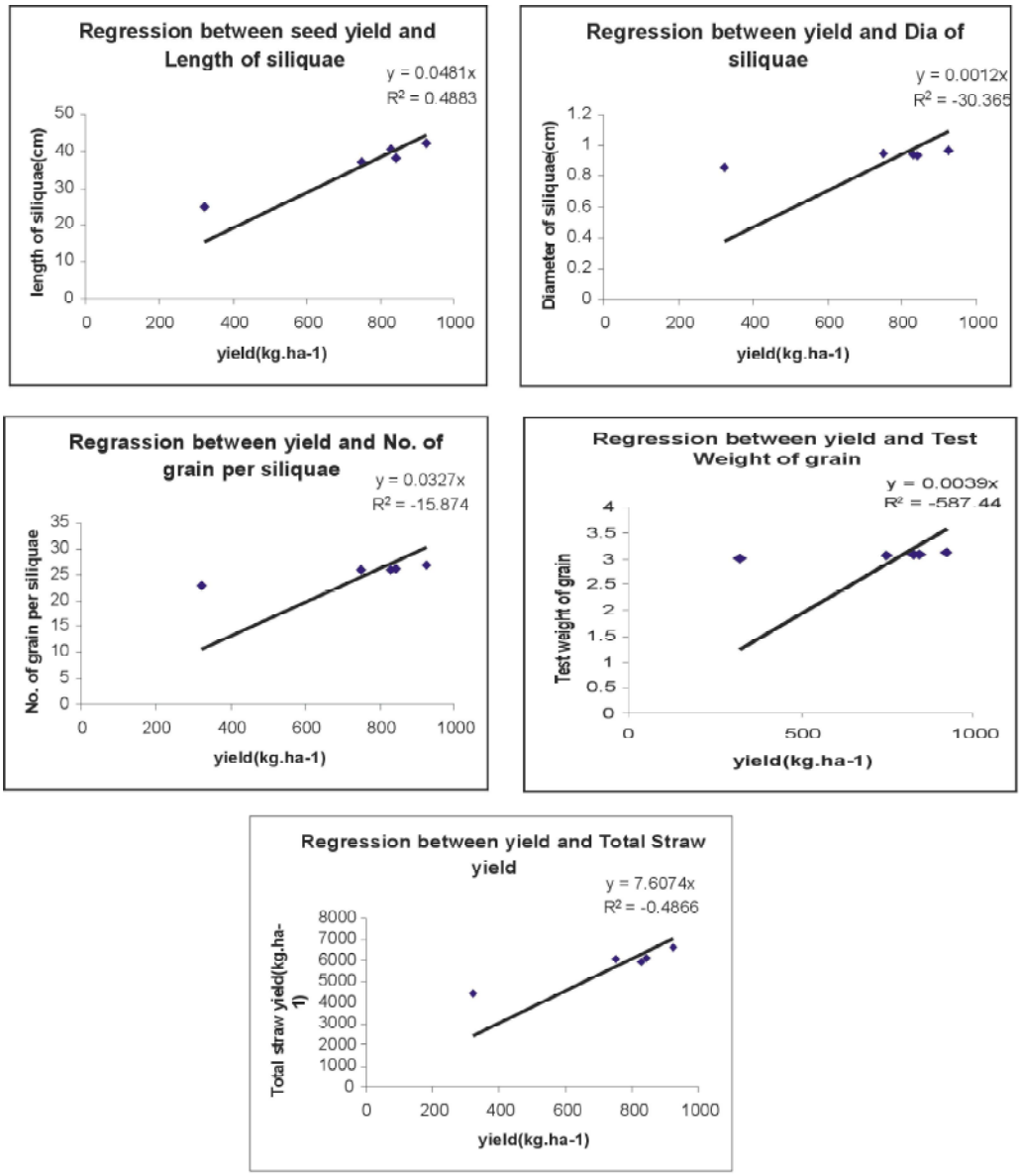

Fig. 1: Scatter plot of various yield attributes with yield values on present study

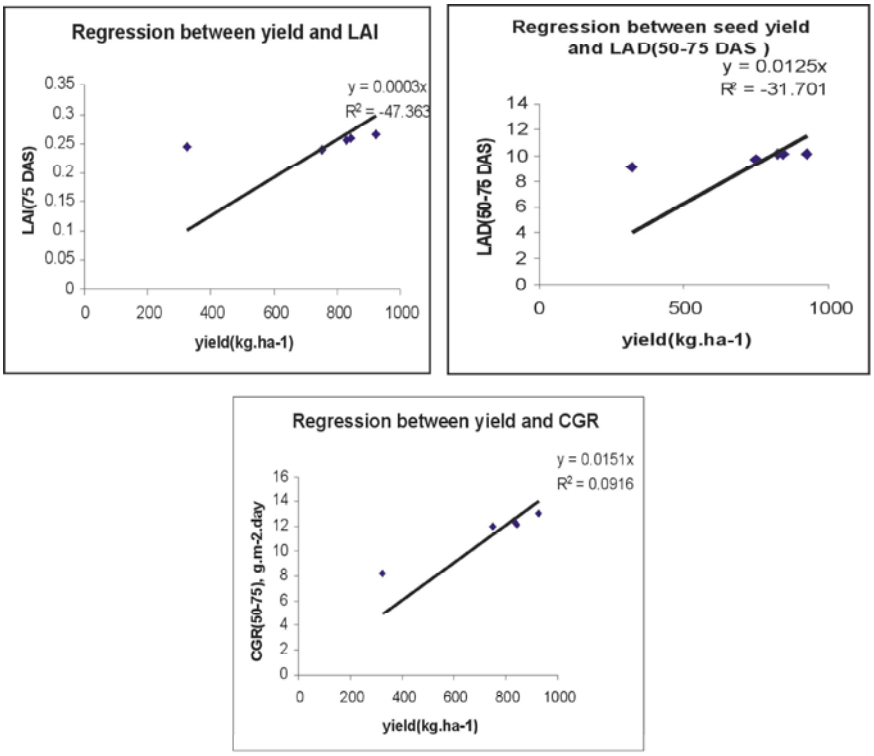

Fig. 2: Scatter plot of various morph physiological attributes with yield values on present study.

Figure 1 and Figure 2 shows the linear regression plots individual variables with yield. From the regression analysis as to mustard cultivars established that there existed significant and positive association between seed yield and length of siliquae and CGR.

There is significant level of increase of soil bacterial and fungal count in soil samples after combined treatment of chemical fertilizer and compost which may be attributed towards the fact that organic manure (compost) contributing towards increase in the mineral nutrients, growth hormones, vitamins and improving other physical characters in soil [27] might have significantly influenced microbial population. The over all effect is increase in soil microbial diversity under such treatments of fertilizer (Table 6).

There is considerable increase in the soil arthropod diversity in soil after combined application of compost and chemical fertilizer, which may be attributed towards enhancement of soil biological activity through addition of compost in soil [28] (Table 7).

Table 6: Soil bacterial and fungal count of soil samples under of five mustard varieties under combined application of chemical fertilizer and compost

		Results	
Varieties		Soil Bacterial count (Cfu's. g soil)	Soil Fumgal Count (CFu's. g soil)
	Before the experiment		
Fallow land		15×10^5	6×10^2
	After the experiment		
V_1		18×10^5	8×10^2
V_2		26×10^5	15×10^2
V_3		29×10^5	30×10^2
V_4		32×10^5	12×10^2
V_5		21×10^5	14×10^2

Table 7: Soil Arthropod diversity in soil samples under of five mustard varieties under combined application of chemical fertilizer and compost

Varieties	Results			
		Order	Family	% of occurance
	Before the experiment			
Fallow land		Coleoptera	Staphylinidae	6
	After the experiment			
V_1		Coleoptera	Coccinellidae	36.36
		Coleoptera	Meloidae	14.28
V_2		Coleoptera	Anobidae	21.42
V_3		Coleoptera	Scarabacidae	7.14
		Coleoptera	Meloidae	9.09
V_4		Coleoptera	Chrysomelidae	10.71
		Coleoptera	Coccinellidae	29.41
V_5		Coleoptera	Anobidae	18.18

Results suggested that the introduction of a high yielding crop variety with balanced application of N, P and K fertilizer along with compost can be recommended to end users. Our present investigation revealed that the best variety of the five mustard varieties under the old alluvial soil agroclimatic zone was Ragini based on attributes of growth, morphophysiology and yield. Therefore Ragini can be cultivated for a better yield of mustard under old alluvial soil zone under recommended dpse of chemical fertilizer and compost. Therefore it can be suggested that judicious use of composts and chemical fertilizers can lead toward increase in yield under the agroclimatic condition of the old alluvial soil of Burdwan, West Bengal, India. Further, from the research results it can be concluded that such type of judicious management of fertilizers often leads to sustainable crop production by improving soil health. These type of practices can therefore be duplicated in farmers field for commercial scale of crop production with less environmental pollution and with good economic returns.

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