Original Research Article

Effect of Liquid Biofertilizer With or Without Vermicompost on Growth and Yield of Field Pea (*Pisum sativum*) Grown Under Laterite Soil of West Bengal

ABSTRACT

A field experiment was conducted at agricultural farm of Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal in *rabi* season of 2022-23 using the field pea cultivar IPFD 10-12. The experiment was laid out in a factorial randomized block design with two factors and ten treatment combinations. The first factor consists of vermicompost i.e., V_1: With vermicompost, V_2: Without vermicompost and the second factor consists of INM i.e., N_1: Absolute Control, N_2: 100 % RDF, N_3: Liquid biofertilizer consortium, N_4: 75 % RDF+ Liquid biofertilizer consortium and N5:100 % RDF + Liquid biofertilizer consortium.The results showed that application of vermicompost 6 t/ha (V_1) recorded higher growth attributes like plant height, leaf area index and dry matter accumulation at 30, 60, 90 and at harvest, yield components like numberofpodsperplant (10.77), number of seeds per pod (4.22) and 1000 grain weight (125.41 g), seed(1535.91 kg/ha) and stover yield(1535.913487.63 kg/ha)while compared to no vermicompost application (V_2). Crop fertilized with 75% RDF + liquid biofertilizers (N_4) showed more growth attributes like plant height, leaf area index and dry matter accumulationat 30, 60, 90 and at harvest, yield components like numberofpodsperplant (12.19), number of seeds per pod (4.61) and 1000 grain weight (127.34 g), seed (1624.05 kg/ha) and stover yield (3550.82 kg/ha)which was at par with 100% RDF + liquid biofertilizers (N_5).

Keywords: Biofertilizer, Field pea, INM and Vermicompost

1. INTRODUCTION

Forfarmersinbothdevelopedanddevelopingnations,pulsesconstituteasignificantcropintermsofrevenue.Pulsecropsareprimarilyproducedandconsumedin India.Pulsescanbegrownasmixed-grainlegumesandaremorecost-effective.Theyalsoincludeahigherproteincontent.Ingeneral,grainlegumeisalsoreferredtoas"poorman'sfood."Worldwide,fieldpeas(*Pisumsativum*)areconsumedbymanypeopleandarerichinprotein,carbs,vitaminsAandC,andtheaminoacidslysineandtryptophan.Indiaisthesecond-biggestpeaproducerintheworld[1].Peasaregrownonover22.42thousandhectaresoflandinIndia,yielding15066thousandtonnesataproductivityof10.40MTperhectare.Withaproductivityof6.72MTperhectare,WestBengalproduces6130thousandtonneson589.63thousandhectaresofland(Agriculturalresearchdatabook,ICAR2022).

Therearetwokindsoffertilizers:chemicalfertilizersandbiologicalfertilizers.BypreservingsoilfertilitythroughbiologicalnitrogenfixationincombinationwiththesymbioticRhizobiumfoundinitsrootnodules,itscultivationpromotessustainableagriculture[2].Theuseofchemicalfertilizersisrequiredtoproducelargecropyields.Increasedchemicaluseassociatedwithintensivefarminghastamperedwiththeequilibriumbetweenplant,soil,andmicrobialpopulationsandcontaminatedgroundwater [3,18].Usingearthworms,vermincastings,andverminwashareproducedviathebioconversionoforganicwasteintovermin [4].Bio-fertilizers are carrier-based inoculants that contain cells of specific strains of effective microorganisms (bacteria) that are used by farmers to fix nitrogen from the atmosphere, solubilize phosphate from the soil, or stimulate plant growth to produce compounds that promote plant growth [5].Utilizingbiofertilizersfromrenewableenergysourcesasanaffordableadditiontochemicalfertilizerscanhelpminimizethesubstantialinvestmentneededforfertilizeruse [6]. AssociativeN_2-fixingbacteriawereintroducedintolegumeseedcrops,changingandenhancingplantgrowthandproductivity. Thesignificanteffectsofbiofertilizersmaybeattributedtodifferentstraingroupsandnutrient-mobilizingmicroorganismsthatfacilitatemetalavailabilityandforminthedecomposedmaterialandincreasedquantitiesofmineralsthatmaybeextracted[7].

Inordertosupportmicrobialdevelopment,liquidbiofertilizercarriershaveasuitablepH,ahighwater-holdingcapacity,andphysicalandchemicalhomogeneity[8].Liquidbiofertilizerstypicallyconsistof35–65%carrierliquid(oilorwater),1-3percentsuspendercomponent,1-4percentdispersion,and10–40percentmicroorganisms.Liquidbiofertilizersshouldcontainuniquecellprotectantsthatpromotethedevelopmentofcystsanddormantspores [9].Alongwiththeirownnitrogenneeds,peasrelease50–60kg/haofresidualnitrogenintothesoil.Accordingto[10],thebalancebetweentheplantandmicrobialpopulationsofthesoilhasbeenupsetbytheheavyuseofpesticidesinintensivefarming.Consideringtheimportanceofintegratednutrientmanagementonfieldpeas,thepresentstudywasconductedtofindtheperformanceoffieldpea(*Pisumsativum*)undertheapplicationofliquidbiofertilizerwithorwithoutvermicomposttodeviseasuitableproductiontechnologyforLateritesoilofWestBengal.

2. MATERIAL AND METHODS

Duringthe*rabi*season,afieldexperimentwascarriedoutin2022-2023attheagriculturalfarmofPalliSikshaBhavana(InstituteofAgriculture),Visva-Bharati,Sriniketan,WestBengal.Thesoilwassandyloamintexture,acidicinsoilpH(5.79),lowinorganiccarbon0.43%(WalkleyandBlack,1934andMuhr*etal.,*1965),lowinavailablenitrogen145.50kg/ha(SubbiahandAsijia,1956),mediuminavailablephosphorus23.50kg/ha(BrayandKurtz,1945)andmediuminavailablepotassium220.1kg/ha(FlamephotometerMethod,Muhr*etal.*1965).Therearetwofactors:1stfactor(Vermicompost) hastwolevel;V_1:WithVermicompostandV_2:WithoutVermicompost.2ndFactor(INM)havefivelevel;N_1:AbsoluteControl,N_2:100%RDF,N_3:Liquidbiofertilizerconsortium,N_4:75%RDF+Liquidbiofertilizerconsortium,N_5:100%RDF+Liquidbiofertilizerconsortiumandtheir10treatmentcombinationswerelaidoutinFactorialRBDwiththreereplications.Well,decomposedvermicompost@6tha^{-1}followedbychemicalfertilizerswereappliedinexperimentalplotaspertreatmentandincorporatedintothesoil thoroughlybeforesowingofthecrop.Chemicalfertilizerssuchasnitrogen,phosphorus(P_2O_5)andpotassium(K_2O)wereapplied@20KgN/ha,60Kg$P_2O_5$$ha^{-1}$,40Kg$K_2O$/hausingurea,singlesuperphosphate(SSP)andmuriateofpotash(MOP),respectivelyaspertreatment.Fullquantityofnitrogen,phosphorusandpotassiumwereappliedasbasalduringsowingtime.Seedswere treatedwithliquidconsortia(liquidbiofertilizers)@250mlper60kgofseeds.Theseedsweretreatedintheevening beforethedayofsowing.Thefieldpeavariety,IPFD10-12,wassownwithaseedrateof70kg/ha,onNovember17,2022withuniformrowtorowspacingof30cmandplanttoplantspacingof10cmatasoildepthof2-3cm.Theexperimentaldatarecordedonvariousparametersweresubjectedtostatisticalanalysisbytheanalysisofvariancemethod(GomezandGomez,1984).Fisher's'F'testatprobabilitylevel0.05testedthesignificanceofdifferentsourcesofvariations.Forthedeterminationofcriticaldifferenceat5%levelofsignificance,FisherandYate'stableswereconsulted.Thevalueofstandarderrorofmean(Sem(±))andtheleastsignificantdifference(CD)tocomparethedifferencesbetweenthetreatmentmeanshavebeenprovidedintables,thecoefficientofvariation(CV %)wasalsogivenineachtable.

3. RESULTS AND DISCUSSION

3.1 GROWTH PARAMETERS

Observationsonvariousgrowthattributesasplantheight,leafareaindexanddrymatteraccumulationrecordedat30DAS,60DAS,90DASandatharvestwerepresentedinTable1.

Withrespecttovermicompostapplication,thesignificantdifferencewasnoticedinplantheightandleafareaindexbytheapplicationofvermicompostduringdifferentgrowthstagesexcept30DAS.Higherplantheightwasrecordedbyapplicationof6tha^{-1}vermicompostcomparedtonovermicompostapplication.Drymatteraccumulationshowedasignificantdifferencewasnoticedindrymatterbytheapplicationofvermicompostduringdifferentgrowthstagesexceptat30DASand60DAS.Byapplicationof6tha^{-1}vermicompostrecordedthehighestdrymattercomparedtonovermicompostapplication.Thismightbeduetobettersoilphysicalconditions,prolongedavailabilityofmajor(NPK),andmicronutrientstocropduringtheentiregrowingseason.Byprovidingassimilatestotheroot,organicmanuresplayasignificantroleinrootgrowthanddevelopment,whichimprovesnoduleformationandnitrogenfixation.Similarresultswerealsoobtainedby[11]incowpeaand[12]inChickpea.

Withrespecttonutrientapplication,thehighestplantheightwasrecordedwhenthecropwasfertilizedwith75%RDF+Liquidbiofertilizerexceptat30DAS.During30DAS,plantfertilizedwithN_5(100%RDF+Liquidbiofertilizer)recordedmaximumplantheightwhichwasatparwithN_2treatment(100%RDF).At60DAS&harvest,N_4(75%RDF+Liquidbiofertilizer)isatparwith

Table 1: Effect ofLiquid Biofertilizer With or Without Vermicompost on Growth parameters of Field Pea

Treatments	Plant height (cm)				Leaf area index			Dry matter accumulation (g/m^2)			
	30	60	90	Harvest	30	60	90	30	60	90	Harvest
Factor(A):VermicompostApplication											
V_1	13.95	28.40	48.31	51.01	0.25	1.14	1.04	50.97	162.63	425.47	467.82
V_2	13.71	26.24	42.96	45.77	0.21	1.02	0.92	49.75	158.87	400.78	436.56
SEm (±)	0.29	0.58	1.09	1.00	0.00	0.02	0.01	1.06	2.95	8.10	8.14
CD (*P* = .05)	NS	1.71	3.25	2.98	0.01	0.05	0.04	NS	NS	24.07	24.19
Factor(B):NutrientApplication											
N_1	11.39	24.68	40.69	39.91	0.11	0.75	0.65	41.88	146.65	370.74	394.79
N_2	15.12	27.85	46.54	49.66	0.22	1.00	0.90	55.38	166.37	426.90	464.90
N_3	12.65	25.54	43.12	44.89	0.15	0.85	0.75	41.83	147.93	396.24	429.62
N_4	14.23	29.92	50.46	55.16	0.38	1.55	1.45	56.72	173.70	444.68	502.95
N_5	15.78	28.63	47.35	52.35	0.29	1.25	1.15	55.99	169.09	427.07	468.68
SEm (±)	0.46	0.91	1.73	1.58	0.01	0.02	0.02	1.67	4.66	12.81	12.87
CD (*P* = .05)	1.37	2.70	5.14	4.70	0.02	0.07	0.07	4.97	13.85	38.07	38.24
Interaction effects											
SEm (±)	0.65	1.28	2.44	2.24	0.008	0.04	0.03	2.36	6.59	18.12	18.20
CD (*P* = .05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	8.14	8.15	9.28	8.02	5.80	5.54	5.58	8.14	7.10	7.60	6.97

Where, V_1: With Vermicompost, V_2: Without Vermicompost, N_1: Absolute Control, N_2: 100 % RDF, N_3: Liquid biofertilizer consortium, N_4: 75 % RDF+ Liquid biofertilizer consortium and N_5: 100 % RDF + Liquid biofertilizer consortium

Table 2: Effect ofLiquid Biofertilizer With or Without Vermicompost on yield and yield attributes of Field Pea

Treatments	No.of pods/ plant	No.of seeds/ pod	1000 grains weight(g)	Seed yield(kg/ha)	Stover yield (kg/ha)	Harvest Index
Factor(A):VermicompostApplication						
V_1	10.77	4.22	125.41	1535.91	3487.63	0.30
V_2	10.10	4.15	120.18	1240.39	3156.97	0.28
SEm (±)	0.22	0.09	3.09	34.98	92.82	0.01
CD (*P* = .05)	0.65	NS	NS	103.92	275.73	0.02
Factor(B):NutrientApplication						
N_1	9.07	3.50	113.96	1040.05	3041.88	0.25
N_2	10.34	4.58	123.95	1444.55	3391.28	0.30
N_3	9.56	3.63	119.57	1293.05	3106.84	0.29
N_4	12.19	4.61	127.34	1624.05	3550.82	0.31
N_5	11.02	4.60	129.17	1539.05	3520.68	0.30
SEm (±)	0.35	0.14	4.89	55.31	146.75	0.01
CD (*P* = .05)	1.03	0.41	NS	164.31	435.96	0.03
Interaction effects						
SEm (±)	0.49	0.19	6.92	78.22	207.54	0.01
CD (*P* = .05)	NS	NS	NS	NS	NS	NS
CV (%)	8.01	8.13	9.16	9.76	10.82	8.02

Where, V_1: With Vermicompost, V_2: Without Vermicompost, N_1: Absolute Control, N_2: 100 % RDF, N_3: Liquid biofertilizer consortium, N_4: 75 % RDF+ Liquid biofertilizer consortium and N_5: 100 % RDF + Liquid biofertilizer consortium

N_5(100%RDF+Liquidbiofertilizer)andN_2treatment(100%RDF).At90DAS,N_4treatmentisatparwithN_5treatment(100%RDF+Liquidbiofertilizer).Significantdifferencewasnoticedduringalldifferentgrowthstageswithrespecttoof LAI.ThehighestLAIwasrecordedwhenthecropwasfertilizedwith75%RDF+Liquidbiofertilizer.ThelowestLAIwasrecordedduringapplicationofN_1(control).Thehighestdrymatterwasrecordedwhenthecropwasfertilizedwith75%RDF+LiquidbiofertilizerwhichwasatparwithN_5treatment(100%RDF+Liquidbiofertilizer)andN_2treatment(100%RDF)at30,60,90DASandharvest.Leguminousplantshavetheuniqueabilitytofixatmosphericnitrogeninthesoil.TheprocessofN-fixationcannotoperatenormallyinabsenceofspecificbacteriainsoil.*Rhizobiumleguminosarum*bacteriabelongingtocrossinoculationgrouparespecifictothisprocessinfieldpea.Inordertoensureeffectiveandefficient nodulation,itisnecessarythatalargenumberofthesebacteriabemaintainedinthesoil.Nitrogenfixershelptheplantbygivingitatmosphericnitrogen,whichhelpsitgrowmoresuccessfully.*Rhizobium*inoculationincreased plantheight,drymatteraccumulation,andLAI.Theseresultsareincloseagreementswith[13,14,15,19].

3.2 YIELD ATTRIBUTES

Observationsonvariousyieldattributesandyieldwererecorded,analyzedandpresentedinTable2.Nosignificantdifferencewasnoticedinnumberofpodsperplant,numberofseedsperpodand1000grainweightbytheapplicationofvermicompost.Byapplicationof6tha^{-1}vermicomposthighernumberofpodsperplantw a s recordedcomparedtonovermicompostapplication.Thepositiveimpactofvermicompostonyieldattributesmaybeattributabletotheincreasedavailabilityofmacro-andmicronutrientsduringtheentiregrowingseason,whichincreasedfoodabsorptionandledtoitssubsequentpartitioninginthesink.Theavailabilityandoptimumsupplyofnutrientsofplantsfavorablyinfluencedthefloweringandseedformation,whichultimatelyincreasedthepodsperplant,seedsperpodandtestweight.Similarresultswerealsoreportedby[11]incowpeaand [12]inChickpea.

Withdifferentnutrientapplicationpractices,significantdifferencewasnoticedinnumberofpodsperplantandnumberofseedsperpod.Thehighestandlowestnumberofpodsperplantwasrecordedwhenthecropfertilizedwith75%RDF+Liquidbiofertilizerandcontrol,respectively.Thehighestnumberofseedsperpodwasrecordedwhenthecropwasfertilizedwith75%RDF+Liquidbiofertilizer.Fornumberofseedsperpod,N_4(75%RDF+Liquidbiofertilizer)isatparwithN_5(100%RDF+Liquidbiofertilizer)andN_2(100%RDF).SeedinoculationwithRhizobium+PSBalongwithRDFenhancedtheyieldattributesduetobalancedavailabilityofNandP.Theseresultsareinlinewiththefindingsof[16].

3.3 YIELD

Significantdifferencewasnoticedinseedandstoveryieldandharvestindexbytheapplicationofvermicompost.Byapplicationof6t/havermicompostrecordedthehighestseedandstoveryieldandharvestindexcomparetonovermicompostapplication. A greater number of sites for the transfer of photosynthates were made available by enhanced vegetative development, which in turn led to an increase in the number of yields[17].

Thehighestseedyieldwasrecordedwhenthecropfertilizedwith75%RDF+Liquid biofertilizer.ForseedyieldN_4(75%RDF+Liquidbiofertilizer)isatparwithN_5(100%RDF+Liquidbiofertilizer).

Whereas the higheststover yieldwasrecordedwhenthecropwas fertilizedwith75% RDF + Liquidbiofertilizerwhichwasstatistically atparwithN_5(100%RDF+Liquid biofertilizer) and N_2(100%RDF). The highestharvestindexwasrecordedwhenthe crop fertilizedwith75% RDF + LiquidbiofertilizerwhichwasatparwithN_5 (100%RDF+Liquidbiofertilizer),N_3 (Liquid biofertilizer) andN_2(100%RDF). It is clear that *Rhizobium* inoculation encouraged N-fixation and increased dry matter and plant production. The increased dry matter accumulation and N content together resulted in greater uptake of N which resulted in higher yield.

4. CONCLUSION

On the basis of results summarized above, it can be concluded that application of vermicompost (6 t/ha) + 75% RDF + liquid biofertilizers resulted in higher growth and productivity for field pea grown under laterite soil of West Bengal.

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