Original Research Article

StudiesonSoilHealthConditionasinfluencedbySoleand IntercroppingSystemof MaizeandPulses underRainfed Conditions

Abstract

Field experimentswas conducted atResearchFarm of divisionof SoilScience andAgricultural Chemistry, Faculty of Agriculture & Regional Research Station, (FOA & RRS)Wadura, SKUAST-K, to investigate the soilhealthconditionasinfluencedbySoleand IntercroppingSystemof Maize andPulses UnderRainfed Conditionswith following aim 1, Impact of Intercropping on Soilhealth condition . 2, Impact ofIntercropping onyieldand dry matteryield of maize-pulse cropand 3, Impact of Intercropping on nutrient content and uptake of N, P, K, Ca and Zn.Seventreatments laid out in a completely randomized block design with three replicates. The croppingsystem consisted of sole maize, sole pulse (local bean), maize + pulse in single row at 60cm inrow ratio (1:1), maize + pulse in paired row at 60cm in row ratio (1:2), maize + pulse in singlerow at 75cm in row ratio (1:1), maize + pulse in paired row at 75cm in row ratio (1:2) and maizewith pulse as mixed cropping. Maize variety SMC4 (Shalimar Maize Composite 4 and Pulsevariety (Local bean, Rajmash) were used.At the end of the vegetative cycle, yield and yieldcomponentsweremeasured. Results showed that at harvest, dry matter yield of treatment T4 (maize + pulse in pairedrow at 60cm in row ratio (1:2) , T6 (maize + pulse in paired row at 75cm in row ratio (1:2) werefoundtobestatisticallyatparbutstatisticallysignificantovertheothertreatmentswithrespectto dry matter yield as compared to the other treatments. Cropping system had a significant effecton maize grain equivalent yield. The maize equivalent yield of treatment T4 (maize + pulse inpairedrow at60cm inrow ratio(1:2),T6 (maize+pulsein pairedrowat75cm inrowratio(1:2) werefoundtobestatisticallyatparbutstatisticallysignificantovertheothertreatments.Effectof cropping system on nutrient content and uptake was found higher in treatment T4 as comparedtoothertreatments.TreatmentT4werefoundstatisticallysignificantatC.D.(P≤0.05)as comparedto other treatments.After harvesting of crop the soil sample (0-15cm) were collected from each plot andanalyzed for various soil properties. The highest bulk density (1.24 Mgm^{-3}) was recorded intreatment T1 (sole maize) and lowest (1.19 Mgm^{-3}) in treatment T2 (sole pulse). Slightly higherpHwasrecordedintreatmentT1(solemaize).Highestsoilorganiccarbon(1.49%)wasfound in treatment T2 (sole pulse) and lowest found in treatment T1 (sole maize). The available N, P, K(kg ha^{-1}) are as follow. Highest N (315.19), P (10.70) and K (212.16) was recorded in treatmentT2 (sole pulse) and lowest N (275.79), P (10.54) and K (207.19) war recorded in treatment T1(solemaize)respectively.Based on these results, it is concluded that increasedintimacy between maize + pulse (local bean) in paired row at 60cm in row ratio 1:2) in anintercropsystemincreased maize yields, nutrientuptakeandimprovesoil healthcondition.

Comment [A1]: The resulting section of the abstract indicate an explanation is too lenghtly; make it as straightforward as possible and tailored to the purpose.

Keywords:Intercropping,rowratio,Maize,pulse,soilhealth,yield,nutrientcontentanduptake.

Introduction

Diversificationofcroppingsystemisnecessarytogethigheryieldandreturns,tomaintainsoilhealth,preserveenvironmentandmeetdaily foodandfodderrequirementofhumans and animals, respectively (Padhi and Panigrahi, 2006). Growing of two or more cropspecies simultaneously in the same field during a growing season is defined as intercropping(Ofori and Stern, 1987). Intercropping is an age-old practice in India, especially under rainfedconditions,whichaimstoincreasetotalproductivityperunitareathroughequitableandjudicious useoflandresourceandfarminginputsincludinglabours.Thisadvancedagrotechnique has been practiced from past decades and achieved thegoal ofagriculture. Risk maybe minimized in intercropping (Woolley and Davis, 1991). The intercropping system besidesmeeting the various requirements of a farmer, also harnesses the farm resources efficiently.Cereal-legume intercropping has potential to provide nitrogen, depends on densities of crop, lightinterception, crop species and nutrients. Intercrops have been identified to conserve water largelybecauseofearly highleafareaindexandhigherleafarea.Cereal-legumeusewatermoreefficiently than monocropping and might be better control of weeds, pests and diseases, as maizeis susceptible to many insects and diseases (Drinwater *et al.*, 2002) and intercropping appears tobe a very promising cultural practice for this purpose and has been suggested as a means to helpcontrol erosion. Banik and Sharma (2009) reported that cereal-legume intercropping systemswere superior to monocropping. Maize-french bean gave high maize equivalent yield over solemaize yield (Hugar and Palled, 2008b) and kernel yield of maize was unaffected in maize-frenchbean intercropping (Pandita, 2001). Intercropping has not only the technique been shown toincrease yields but it is also a useful means of spreading risk: if one crop fails another may stillprovide sufficient food until the next harvest (Trenbath, 1999). Development of feasible andeconomicallyviableintercroppingsystemlargelydependsonadoptionofproperplantinggeometry, planting time, selectionof compatible cropsandnutrientmanagementinrainfedconditions. To feed the exponentially growing world population, intercropping is an importantagronomic strategy that involves the growing of two or more crops on the same piece of landKatyayan,2005).Itisanancientagronomicpracticeusedintraditionalagricultureandstillin vogue in most of the developing countries. Intercropping system maximizes the productivity aswell as resource utilization per unit of land. Almost all the concerns for agriculture (agriculturetechnologies, government farm policies, modern crop varieties and research efforts) are focusedon the production of sole cropping, while somedrawbacks in modern agriculture system forcethe farmers to take interest in intercropping for the production of fiber and food (Kirschenmann,2007; Vandermeer, 1989). Intercropping systems provide 15–20% of food supply to the world(Lithourgidis *et al.*, 2011). In fact, intercropping has ecological, biological and socioeconomicadvantagesover solecropping(Heet al., 2012; Waktola*et al*., 2014).

Legumes fix the atmospheric nitrogen with the help of rhizobiumbacteria lives in the root nodules of host plant. Maize plant take the nitrogen from the soil for itsgrowth and development in the opposite rhizobium plant take the food from host plant. Maizeplantalsogivessupporttopulsefortheirgrowth.Keepingtheabovecitedfactsintoconsideration,th epresentinvestigationdesignated**"StudiesonSoilHealthCondition influencedbySoleandIntercroppingSystemofMaizeandPulseunderRainfedCondition"**has been undertaken.

AIM:

- To find out the impact of intercropping on soil health.
- To study the impact of intercropping on yield and dry matter yield of maize-pulse crop.
- To study the impact of intercropping on nutrient content and uptake of N, P and K by maize-pulse crop.

Materials and methods

Location and existing soil Nutrient status

A field experiment entitled "Studies on Soil Health Condition as influenced by Soleand Intercropping System of Maize and Pulse under Rainfed Conditions" was conducted atResearch Farm of division of Soil Science and Agriculutral Chemistry, Faculty of Agriculture &Regional Research Station, (FoA & RRS) Wadura, SKUAST-K.

Experiment Details

Weatherconditionduringthe cropping season

The climate is temperate and continental type characterized by hot summers and severewinters with average annual precipitation is 812 mm (average of past thirty years) and more than80 per cent of precipitation occurs during December to April in the form of rains and snowreceived from western disturbances. The monthly mean meteorological data collected during thecrop growing season is presented in Fig.1. It is evident from data that mean maximum andminimumtemperaturesduring2019were33.34^{o}Cand6.81^{o}Crespectively.Themeanmaximum and minimum relative humidity were 87.57% and44% respectively.The totalprecipitationamounted to 398.1 mm duringcropgrowth season.

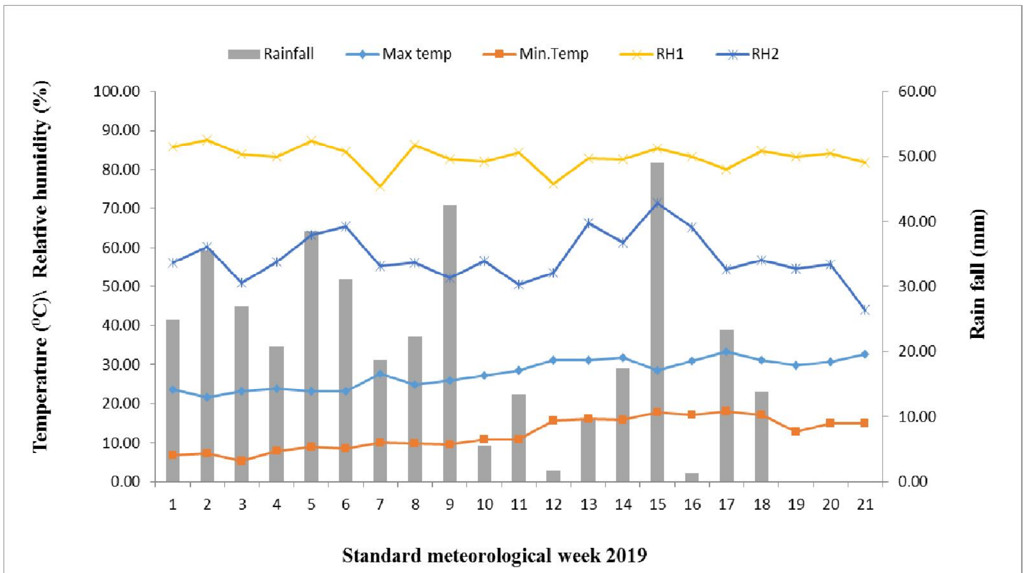

Fig 1 :Weatherconditionduring crop growingperiod

The experiment was laid out in completely randomized block design (RCBD), comprising of eight treatments and three replications. As Presented in(Table 1).

Table 1. Experiment details

TreatmentsCombinations

- **i)** T_1=SoleMaize
- **ii)** T_2=SolePulse
- **iii)** T_3=Maize+Pulseinsinglerowat60cm(1:1)
- **iv)** T_4=Maize+Pulsein pairedrowat 60cm(1:2)
- **v)** T_5=Maize+Pulseinsinglerowat75cm(1:1)
- **vi)** T_6=Maize+Pulsein pairedrowat 75cm(1:2)
- **vii)** T_7=Maize+Pulse asmixed cropping

Vermicompost at the rate 10 t $ha^{-1}$was uniformly applied 10 days before sowing to eachplot and well mixed with soil. The fertilizer dose of 120:60:30 kg ha^{-1} were applied to the crop.Full dose of phosphorus and potassium through diammonium phosphate and muriate of potashrespectively and half dose of nitrogen through urea was applied to each plot before sowing andremaining half dose of nitrogen through urea was top dressed in two equal splits, one at 30-35daysafter sowingat kneehigh stageand 2^{nd}10to12 days beforetsellingstage.

Results& discussion

Comment [A2]: In this section, please add one or more of the newest literature to support your argument

EffectofcroppingsystemonDrymatteraccumulation(qha^{-1})

Thetreatmenteffectsondrymatteraccumulationatharvesthavebeenpresentedin(Table2) andthesamehasbeenrepresentedgraphicallyin(Fig2).Atharvestthedrymatterproduction recorded under sole maize T1 was significantly higher than other treatments but wasat par with T4, T6 and T7. Amongst the intercrop treatments, T4 recorded significantly high drymatter accumulation over various other treatments. The study also revealed that significantlylowestperiodicdrymatter accumulationwasobserved under solepulse (local bean).

Table-2:Effectof croppingsystemondrymatteryield (qha^{-1})ofmaize-pulsecrop.

Treatment	**DryMatterYield (q ha^{-1})**
T1	136.90
T2	47.90
T3	87.90
T4	118.60
T5	79.20
T6	101.30
T7	113.10
Mean	97.84
SE(m)	1.09
C.D.**(P≤0.05)**	3.41

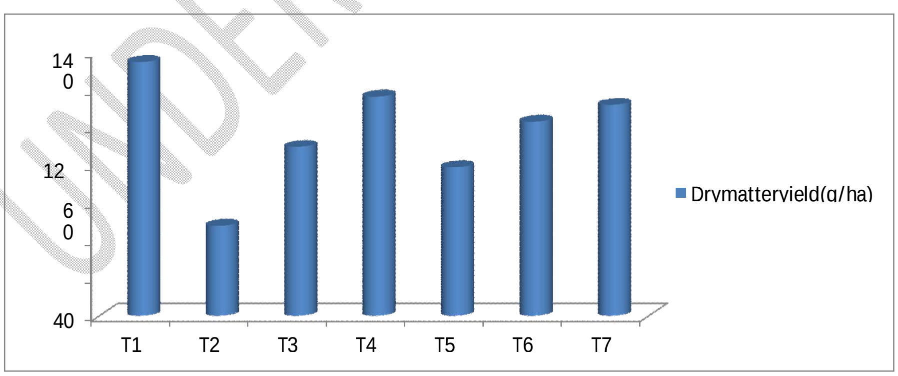

Fig-2:Effectof croppingsystemondrymatteryield (qha^{-1})ofmaize-pulsecrop.

Effectof croppingsystemonMaizeEquivalentYield.

The results (Table 3) and the same has been represented graphically in (Fig 3) showedsignificantvariationwithregardtothemaizeequivalentyieldofvarioustreatments.Thetreatment T4 at par with T6 recorded significantly highest maize equivalent yield (63.33) overrest of the treatment. Significantly, lowest maize equivalentyield was recorded with treatmentT2(13.50)whichwasfollowedbyT7(52.72),T5(58.05),T3(58.42)andT6(61.54)respectively.

Table3:Effectofcroppingsystemonmaizeequivalentyield(qha^{-1})of maize-pulsecrop.

Treatment	MEY(q/ ha)
T1	36.00
T2	13.50
T3	58.42
T4	63.33
T5	58.05
T6	61.54
T7	52.72
Mean	49.08
SE(m)	1.32
C.D.**(P≤0.05)**	4.13

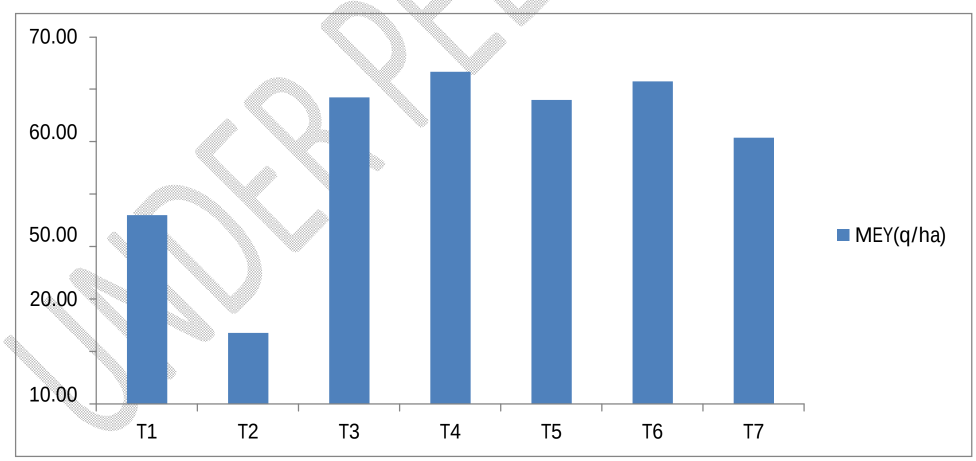

Fig 3:Effectofcroppingsystemonmaizeequivalentyield(qha^{-1})of maize-pulsecrop.

Effect of cropping system on nutrient content and nutrient uptake (N, P and K) bymaize-pulse crop

Nitrogencontent (%)

The data on nitrogen content as affected by different treatments is presented in (Table 4)and graphically presented in (Figure 4). From the perusal of the data is evident that the treatmentT2 (sole pulse) recorded significantly higher nitrogen content over T1, T7 and T5. T2 was thenexttreatmentwhichshowedsignificantlyhighernitrogencontentoverT1,howeveritwasatpar with rest of the treatments. Significantly lowest nitrogen content was recorded under thetreatmentT1.

Nitrogen uptake(kg ha^{-1})

The data presented in (Table 4) and graphically presented in (Figure 4) indicate widevariation amongst treatments with regard to nitrogen uptake by different treatments at harvest.The results infer that treatment T4 (198.06) being at par with T1 (169.75) and T7 (168.51)recordedhighestNuptakeoverothertreatments.Significantlylowestnitrogenuptakeof(128.30)was recorded byT5treatment whichwasfollowed byT2,T3 andT6.

Phosphoruscontent(%)

Table4andgraphicallypresentedin(Figure4)recordsthedatapertainingtophosphorus content at harvest as influenced by different treatments. The data indicated thattreatments T1 and T4 being at par with all the treatments except T2 and T5 recorded significantlyhighestphosphorus content of (0.45Phosphorusuptake(kgha^{-1})

Thedataofphosphorusuptake(Table4)andgraphicallypresentedin(Figure4)indicated wide variation amongst the treatments during the period of experimentation. From theperusal of the data it is evident that treatment T1 recorded phosphorus uptake of (61.60) whichwas statistically higher than all other treatments tested. The next treatment recording highestphosphorusuptakewasT4(53.37)whichwassignificantlysuperiortoothertreatments.Significantly lowest phosphorus uptake was observed with T2 treatment (18.00) during period ofinvestigation.

Potassiumcontent(%)

The potassium content varied markedly due to influence of various treatments duringexperimentation (Table 4) and graphically presented in (Figure 4). The data revealed thattreatment T2 at par with T4, T6, T3, T5 and T7 recorded potassium contents of 2.93, 2.45, 2.43,2.42,2.41and2.19percent,respectively,whichwassignificantly higherthanrestofthetreatments tested. Significantly lowest potassium contents of 1.95 were noticed under treatmentT1.

Potassiumuptake(kgha^{-1})

The data presented in (Table 4) and graphically presented in (Figure 4) shows the effectof different treatments on potassium uptake of during the course of experimentation. From theperusal of data, it is evident that the treatment T4 at par with T1, T7, T6 and T3 recorded thepotassium uptake of 290.57, 266.96, 247.68, 246.16 and 212.72 kg ha^{-1} which was significantlyhigherthan remainingtreatments.TreatmentT5recordedstatisticallylowestpotassiumuptakeof 190.87kgha^{-1} duringthe courseofinvestigation.

Table 4 :Effectofcroppingsystemonnutrientcontentandnutrientuptake N,P andKof maize-pulsecrop

Treatments	N Content (%)	N (kgha^{-1})	P Content(%)	P (kg ha^{-1})	K Content(%)	K (kg ha^{-1})
T1	1.250	169.75	0.450	61.60	1.950	266.96
T2	2.090	139.40	0.270	18.00	2.930	195.43
T3	1.640	144.16	0.370	32.52	2.420	212.72
T4	1.670	198.06	0.450	53.37	2.450	290.57
T5	1.620	128.30	0.340	26.92	2.410	190.87
T6	1.650	167.14	0.360	36.46	2.430	246.16
T7	1.490	168.51	0.390	44.10	2.190	247.68
Mean	1.641	164.90	0.375	38.99	2.397	235.77
SE(m)	0.006	0.62	0.006	0.61	0.003	0.62
C.D.(P≤0.05)	0.019	1.93	0.019	1.92	0.010	1.93

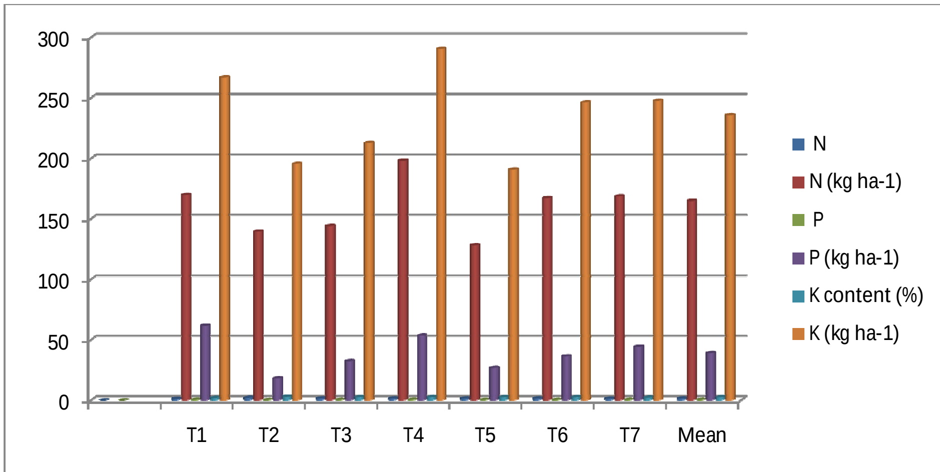

Fig 4 :Effectof croppingsystemonnutrient contentandnutrientuptake N,P,K, CaandZnofmaize-pulsecrop.

Conclusion

Basedonresultsofoneyearexperimentation,itseemslogicalto concludethatMaize + pulse (local bean) in paired row at 60 cm in row ratio (1:2) was found to be the mostcompatibleintercroppingsystemasthissystemproducedhigheryieldanddrymatteraccumulationatpar withthesolecropbesidesadditionalyieldfromlegumecomponent. When maize is grown in association with leguminous crop, it provides a greater scope forminimizing the adverse impact of moisture and nutrient stress in addition to improving systemproductivityand soilhealth (chemical,biological,andphysical environmentof thesoil).

Implications

It is recommended that for better soil health condition maize + pulse (local bean) in paired row at 60 cm in row ratio (1:2) for rainfed soil of Kashmir valley.

Data Availability: All the data pertaining to this research is included within the text

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Comment [A3]: For reference,thereismuchliterature not up to date or in the last 10 years, please add some of thenewest literature

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