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Studies on Soil Health Condition as influenced by Sole and Intercropping System of Maize and Pulses under Rainfed Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Field experiments was conducted at Research Farm of division of Soil Science and Agricultural Chemistry, Faculty of Agriculture & Regional Research Station, (FOA & RRS) Wadura, SKUAST-K, to investigate the soil health condition as influenced by Sole and Intercropping System of Maize and Pulses Under Rainfed Conditions with following aim 1, Impact of Intercropping on Soil health condition. 2, Impact of Intercropping on yield and dry matter yield of maize-pulse crop and 3, Impact of Intercropping on nutrient content and uptake of N, P, K, Ca and Zn. Seven treatments laid out in a completely randomized block design with three replicates. The cropping system consisted of sole

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maize, sole pulse (local bean), maize + pulse in single row at 60cm in row ratio (1:1), maize + pulse in paired row at 60cm in row ratio (1:2), maize + pulse in single row at 75cm in row ratio (1:1), maize + pulse in paired row at 75cm in row ratio (1:2) and maize with pulse as mixed cropping. Maize variety SMC4 (Shalimar Maize Composite 4 and Pulse variety (Local bean, Rajmash) were used. At the end of the vegetative cycle, yield and yield components were measured. Results showed that at harvest, dry matter yield of treatment T4, T6 were found to be statistically at par but statistically significant over the other treatments. Cropping system had a significant effect on maize grain equivalent yield. The highest bulk density (1.24 Mgm^{-3}) was recorded in treatment T1 and lowest (1.19 Mgm^{-3}) in treatment T2. Slightly higher pH was recorded in treatment T1. Highest soil organic carbon (1.49%) was found in treatment T2 and lowest found in treatment T1. 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 treatment T2 and lowest N (275.79), P (10.54) and K (207.19) war recorded in treatment T1respectively.Based on these results, it is concluded that increased intimacy between maize + pulse (local bean) in paired row at 60cm in row ratio 1:2) in an intercrop system increased maize yields, nutrient uptake and improve soil health condition.

Keywords: Intercropping; row ratio; Maize; pulse; soil health; yield; nutrient content and uptake.

1. INTRODUCTION

"Diversification of cropping system is necessary to get higher yield and returns, to maintain soil health, preserve environment and meet daily food and fodder requirement of humans and animals, respectively" [1]. "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 rainfed conditions, which aims to increase total productivity per unit area through equitable and judicious use of land resource and farming inputs including labours. This advanced agro technique has been practiced from past decades and achieved the goal of agriculture. Risk may be minimized in intercropping" (Woolley and Davis, 1991). The intercropping system besides meeting 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, light interception, crop species and nutrients. Intercrops have been identified to conserve water largely because of early high leaf area index and higher leaf area. Cereal-legume use water more efficiently than mono cropping and might be better control of weeds, pests and diseases, as maize is susceptible to many insects and diseases [2,3-5] and intercropping appears to be a very promising cultural practice for this purpose and has been suggested as a means to help control erosion. Banik and Sharma [6] reported that "cereal-legume intercropping systems were superior to mono cropping". Maize- french bean gave high maize equivalent yield over sole maize yield [7] and kernel yield of maize was unaffected in maize-french bean intercropping (Pandita, 2001). "Intercropping has not only the technique been shown to increase yields but it is also a useful means of spreading risk: if one crop fails another may still provide sufficient food until the next harvest" (Trenbath, 1999). "Development of feasible and economically viable intercropping system largely depends on adoption of proper planting geometry, planting time, selection of compatible crops and nutrient management in rainfed conditions [8-11]. To feed the exponentially growing world population, intercropping is an important agronomic strategy that involves the growing of two or more crops on the same piece of land" [12]. It is an ancient agronomic practice used in traditional agriculture and still in vogue in most of the developing countries. Intercropping system maximizes the productivity as well as resource utilization per unit of land. Almost all the concerns for agriculture (agriculture technologies, government farm policies, modern crop varieties and research efforts) are focused on the production of sole cropping, while some drawbacks in modern agriculture system force the farmers to take interest in intercropping for the production of fiber and food [13], Vandermeer, 1989). Intercropping systems provide 15–20% of food supply to the world [14]. In fact, intercropping has ecological, biological and socio economic advantages over sole cropping (He et al. 2012; Waktola et al. 2014).

Legumes fix the atmospheric nitrogen with the help of rhizobium bacteria lives in the root nodules of host plant. Maize plant take the nitrogen from the soil for its growth and development in the opposite rhizobium plant take the food from host plant [15,16]. Maize plant also gives support to pulse for their growth. Keeping the above cited facts into consideration, the present investigation had 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.

2. MATERIALS AND METHODS

2.1 Location and Existing Soil Nutrient Status

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

2.2 Experiment Details

2.2.1 Weather condition during He cropping season

The climate is temperate and continental type characterized by hot summers and severe winters 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 snow received from western disturbances [17-20]. The monthly mean meteorological data collected during thecrop growing season is presented in Fig. 1. It is evident from data that mean maximum and minimum temperatures during 2019 were 33.34ºC and 6.81ºC respectively. The mean maximum and minimum relative humidity were 87.57% and44% respectively. The total precipitation amounted to 398.1 mm during crop growth season.

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

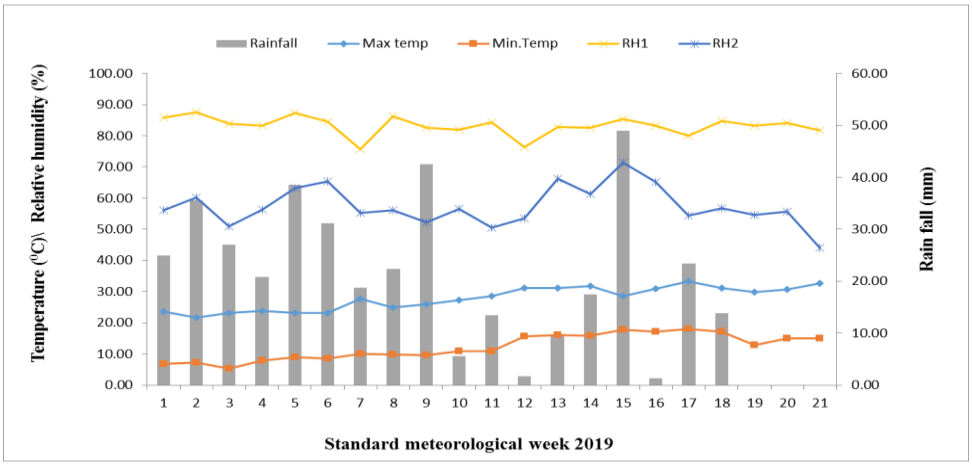

Fig. 1. Weather condition during crop growing period

Table 1. Experiment details

Treatments Combinations	
i)	T_1=Sole Maize
ii)	T_2=Sole Pulse
iii)	T_3=Maize+Pulseinsinglerowat60cm (1:1)
iv)	T_4= Maize+ Pulse in paired row at 60cm (1:2)
v)	T_5=Maize+Pulseinsinglerowat75cm (1:1)
vi)	T_6= Maize+Pulsein paired row at 75cm (1:2)
vii)	T_7= Maize+Pulse as mixed cropping

Vermicompost at the rate 10 t ha^{-1}was uniformly applied 10 days before sowing to each plot 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 potash respectively and half dose of nitrogen through urea was applied to each plot before sowing and remaining half dose of nitrogen through urea was top dressed in two equal splits, one at 30-35daysafter sowing at knee high stage and 2nd10to12 days before tselling stage.

3. RESULTS AND DISCUSSION

3.1 Effect of Cropping System on Drymatter Accumulation (qha^{-1})

The treatment effects on drymatter accumulation at harvest have been presented in (Table 2) and the same has been represented graphically in (Fig. 2). At harvest the drymatter production recorded under sole maize T1 was significantly higher than other treatments but was at par with T4, T6 and T7. Amongst the intercrop treatments, T4 recorded significantly high dry matter accumulation over various other treatments. The study also revealed that significantly lowest periodic drymatter accumulation was observed under sole pulse (local bean). Similar findings were reported by Sharma et al. (2008).

3.2 Effect of Cropping System on Maize Equivalent Yield

The results (Table 3) and the same has been represented graphically in (Fig. 3) showed significant variation with regard to the maize equivalent yield of various treatments. The treatment T4 at par with T6 recorded significantly highest maize equivalent yield (63.33) over rest of the treatment. Significantly, lowest maize equivalent yield was recorded with treatment T2 (13.50) which was followed by T7 (52.72), T5 (58.05), T3(58.42) and T6(61.54) respectively.

Table 2. Effect of cropping system on drymatter yield (qha^{-1}) of maize-pulse crop

Treatment	Dry Matter Yield (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

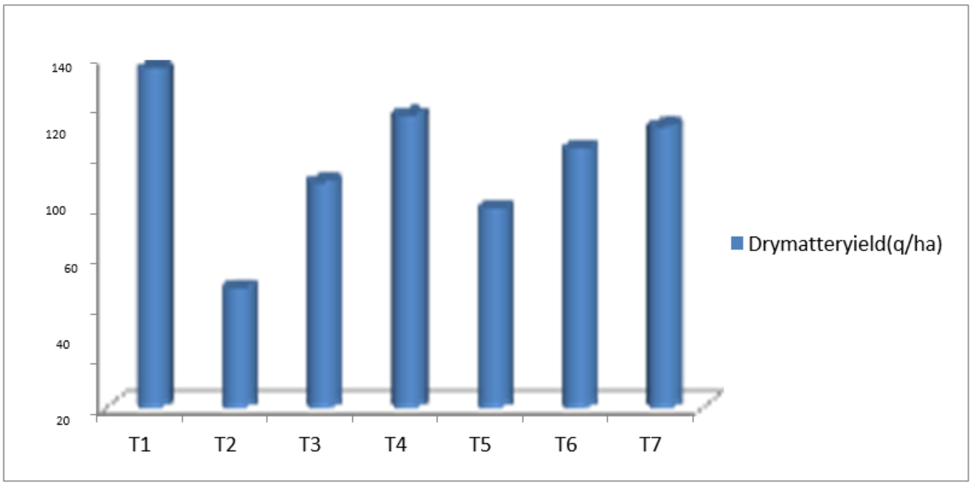

Fig. 2. Effect of cropping system on drymatter yield (qha^{-1}) of maize-pulse crop

Table 3. Effect of cropping system on maize equivalent yield (qha-1) of maize-pulse crop

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

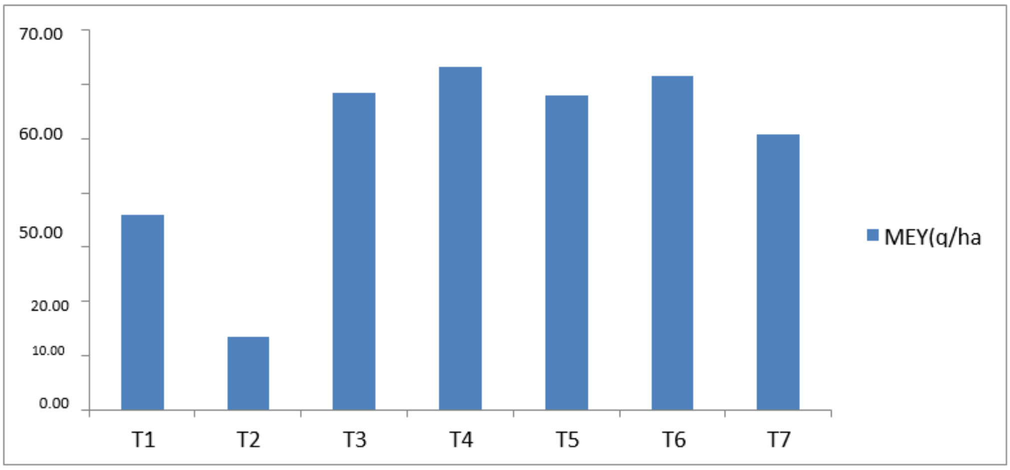

Fig. 3. Effect of cropping system on maize equivalent yield (qha-1) of maize-pulse crop

3.3 Effect of Cropping System on Nutrient Content and Nutrient Uptake (N, P and K) byMaize-Pulse Crop

3.3.1 Nitrogen content (%)

The data on nitrogen content as affected by different treatments is presented in (Table 4) and graphically presented in (Fig. 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 the next treatment which showed significantly higher nitrogen content overT1, however it was at par with rest of the treatments. Significantly lowest nitrogen content was recorded under the treatmentT1.

3.3.2 Nitrogen uptake (kg ha-1)

The data presented in (Table 4) and graphically presented in (Fig. 4) indicate wide variation 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) recorded highest N uptake over other treatments. Significantly lowest nitrogen uptake of (128.30) was recorded byT5 treatment which was followed byT2, T3 andT6. Latha and Singh (2003) also reported that N, P and K uptake was higher in sole sorghum as compared to intercropping with cowpea.

3.3.3 Phosphorus content (%)

Table4 and graphically presented in (Fig. 4) records the data pertaining to phosphorus content at harvest as influenced by different treatments. The data indicated that treatments T1 and T4 being at par with all the treatments except T2 and T5 recorded significantly highest phosphorus content of (0.45 Phosphorus uptake (kgha-1) The data of phosphorus uptake (Table 4) and graphically presented in (Fig. 4) indicated wide variation amongst the treatments during the period of experimentation. From the perusal of the data it is evident that treatment T1 recorded

Table 4. Effect of cropping system on nutrient content and nutrient uptake N,P and K of maize-pulse crop

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

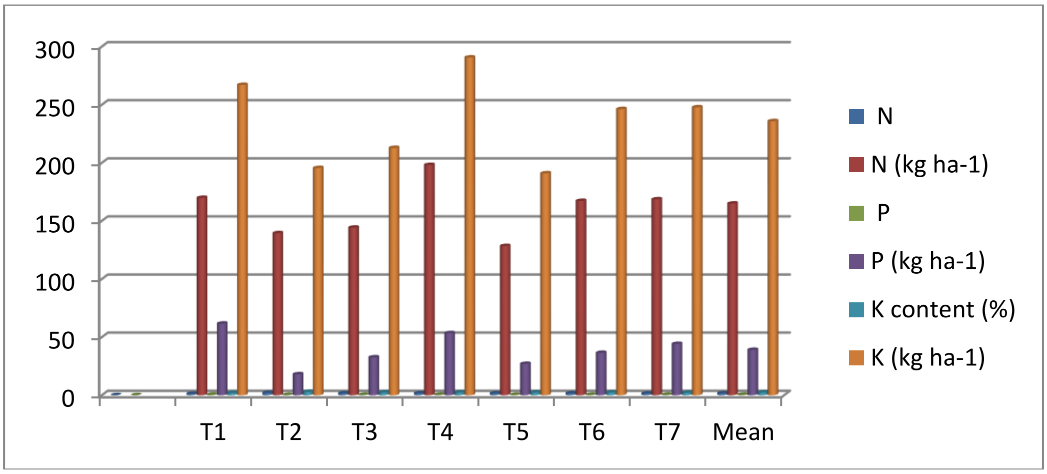

Fig. 4. Effect of cropping system on nutrient content and nutrient uptake N,P,K, Ca and Zn of maize-pulse crop

phosphorus uptake of (61.60) which was statistically higher than all other treatments tested. The next treatment recording highest phosphorus uptake was T4 (53.37) which was significantly superior to other treatments. Significantly lowest phosphorus uptake was observed with T2 treatment (18.00) during period of investigation.

3.3.4 Potassium content (%)

The potassium content varied markedly due to influence of various treatments during experimentation (Table 4) and graphically presented in (Fig. 4). The data revealed that treatment T2 at par with T4, T6, T3, T5 and T7 recorded potassium contents of 2.93, 2.45, 2.43,2.42,2.41and 2.19 percent, respectively, which was significantly higher than rest of the treatments tested. Significantly lowest potassium contents of 1.95 were noticed under treatment T1.

3.3.5 Potassium uptake (kgha^{-1})

The data presented in (Table 4) and graphically presented in (Fig. 4) shows the effect of different treatments on potassium uptake of during the course of experimentation. From the perusal of data, it is evident that the treatment T4 at par with T1, T7, T6 and T3 recorded the potassium uptake of 290.57, 266.96, 247.68, 246.16 and 212.72 kg ha^{-1} which was significantly higher than remaining treatments. Treatment T5 recorded statistically lowest potassium uptake of 190.87kgha^{-1} during the course of investigation.

4. CONCLUSION

Based on results of one year experimentation, it seems logical to conclude that Maize + pulse (local bean) in paired row at 60 cm in row ratio (1:2) was found to be the most compatible intercropping system as this system produced higher yield and drymatter accumulation at par with the sole crop besides additional yield from legume component. When maize is grown in association with leguminous crop, it provides a greater scope for minimizing the adverse impact of moisture and nutrient stress in addition to improving system productivity and soil health (chemical, biological, and physical environment of the soil).

5. 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.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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