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Original Research Article

Comparative and Interactive Effects of Organic and Inorganic Amendments on Soybean Growth, Yield and Selected Soil Properties

Aqila Shaheen*, Rabia Tariq and Abdul Khaliq
Department of Soil and Environmental Sciences, The University of Poonch, Rawalakot, Azad Jammu and Kashmir

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*Corresponding author email:
aqeela.shaheen@gmail.com

Abstract

The absolute use of inorganic fertilizers, growing of exhaustive crops, nutrient losses with runoff and leaching under mountainous sub humid conditions has declined the soil fertility and productivity. The field experiment was carried out to study the comparative and interactive effect of organic and inorganic amendments on soybean growth, yield and soil properties. The experimental design was randomized complete block design (RCBD) with three replications. The treatments combination were control (no amendments); 100 kg N ha^{-1} from urea nitrogen (UN100); 100 kg N ha^{-1} from poultry manure (PMN100); 100 kg N ha^{-1} from sawdust (SDN100); 100 kg N ha^{-1} from UN + PM (UN50 + PMN50); 100 kg N ha^{-1} from UN + SD (UN50 + SDN50); 100 kg N ha^{-1} from PM + SD (PMN50 + SDN50); 100 kg N ha^{-1} from UN + SD + PM (UN50 + SDN25 + PMN25). Results indicated higher crop growth in UN50 + SDN25 + PMN25. However, SDN100 showed lower growth but higher than control.UN100 had statistically higher grain yield (1322.7 kg ha^{-1}) and it was non-significant with UN50+PMN50 and UN50+ PMN25+SDN25. Nitrogen uptake (156.55 kg ha^{-1}) was higher in UN100, UN50+ PMN50 and UN50+ PMN25+SDN25. Post-harvest soil properties showed the minimum pH in SDN100 and higher organic matter in organic and integrated applications. The higher phosphorus contents were in UN50+PMN50. This study showed that SD and PM combined with urea have potential in soybean growth enhancement, yield increase and in improvement of soil properties.

Keywords: Poultry manure, sawdust, integrated nutrient management, soybean

Introduction

Soil fertility is very important for maximum crop production and sustainable agriculture. The role of organic matter (OM) is universally understood in improving and sustaining soil fertility and productivity. Smallholder farmers in the Rawalakot (Latitude 33º 51 to 33º 85 N and Longitude 73º 48 to 73º 80 E) Azad Kashmir are facing problems of declining soil fertility due to cultivation of exhaustive crops (wheat-maize), nutrient removal with crop harvest and soil erosion. The topographic features of terrain, erratic and high intensity rainfall, surface runoff and leaching of nutrients further augment the problem of soil fertility (Tiwari *et al*., 2010) and lower the nitrogen use efficiency (Zaman *et al*., 2009). The use of mineral N fertilizers not only diminishes soil OM but also causes soil acidification and micronutrient deficiencies (Abera *et al*., 2012).

The soybean (*Glycine max*) is a legume and if properly inoculated, can use the nitrogen in the atmosphere (N_2) for plant growth. Therefore, nitrogen fertilizer is not needed for soybean production in most situations. In the previous studies conducted at Rawalakot Azad

Jammu and Kashmir, exotic Bardyrhizobium displayed a significant increase in yields of soybean compared to the non-inoculated control (Abbasi *et al*., 2008; Abbasi *et al*., 2010). But for higher soybean yield in N deficient soils, without inoculum higher application of N fertilizers is required. Soybean's upper limit for N fixation (considered to be about 300 lb/acre) combined with the upper limit of the soil supply (usually less than 100 lb/acre) are insufficient to meet the needs of a 100 bu/acre soybean crop (Salvagiotti et al., 2008). The higher rate of N application (100 kg ha-1) without inoculum gives higher soybean yield in sub-humid, N-poor region of Rawalakot (Khaliq et al., 2015). However, when inorganic fertilizers are applied repeatedly soil degradation due to loss of OM along with continuous cropping becomes worsen. Pandey *et al.*, (2006) reported that application of manures, irrespective of sources and rates recorded significantly higher SOC, N, P_2O_5 and K_2O compared to control.

Poultry manure is nutrient rich organic amendment compare to other organic amendments (Ano and Agwu, 2005). Organic amendments has been a rich source of nutrients and mostly added to soil on the N crop requirements (Qian *et al.*, 2004). The sawdust is another cheap and easily available organic waste and has the potential to supply nutrients to crops (Owolabi *et al*., 2003). Sawdust immobilizes soil N (Cogger, 2005) consequently, additional N is necessary with sawdust to counterbalance the immobilization. Organic inputs are low-cost and ecofriendly but the full benefits cannot be obtained from organic amendment as its bulky hence higher transportation and management cost is required in its handling. Therefore, integrated farming system is an agricultural system conceived so as combating environmental degradation on one hand and increase productivity on other hand. The integrated application of organic and inorganic nutrients results in higher crop productivity (Adeniyan and Ojeniyi, 2005), buildup of soil organic matter and higher level of major soil nutrients especially nitrogen and phosphorus (Huang *et al*., 2007). Earlier studies have reported higher soybean-wheat productivity with integrated application of organic manures and inorganic fertilizers (Bhattacharyya *et al*., 2010; Shah *et al*., 2009).

Keeping in view the importance of soybean and easy availability of organic amendments i.e. poultry manure and saw dust, study was planned with the objective:

- To study the comparative effects of organic amendments (SD and PM) and urea N on soybean growth and yield.
- To study the comparative effects of organic and inorganic amendments on selective soil properties.

Materials and Methods

Experiment description and treatments

A field trial was conducted at chottagala experimental farm area of The University of Poonch Rawalakot, Azad Jammu & Kashmir-Pakistan. The experiment was randomized complete block design (RCBD) and each treatment was replicated thrice. The treatments were including application of organic and inorganic sources and the rate of sources was calculated on the N equivalent basis at the rate of 100 kg N ha^{-1} (Khaliq *et al.*, 2015). The treatment combinations were:

Control (no amendments)
UN_{100}; 100 kg N ha^{-1} from urea nitrogen
PMN100; 100 kg N ha^{-1} from poultry manure
SDN100; 100 kg N ha^{-1} from sawdust
UN_{50} + PMN50; 100 kg N ha^{-1} from UN + PM
UN_{50} + SDN50; 100 kg N ha^{-1} from UN + SD
PMN50 + SDN50; 100 kg N ha^{-1} from PM + SD
UN_{50} + SDN25 + PMN25; 100 kg N ha^{-1} from UN + SD + PM

Poultry manure was collected from local poultry farms and sawdust was collected from local market. Saw dust was partially decomposed and before application it was properly mixed, air dried and was mixed in the field one month before crop sowing. Poultry manure was well decomposed and applied to field at sowing of crop. Poultry manure had 1.8% nitrogen while saw dust had 0.5% N. Soybean was sown in the month of May. The basal doses of 60 kg $ha^{-1}$of K_2O and 40 kg $ha^{-1}$of P_2O_5 were applied as sulphate of potash (SOP) and single super phosphate (SSP) respectively. Urea nitrogen was applied half at the time of sowing of crop and half at the stage of nodule formation.

Soil analysis

Soil samples were collected at 15 cm depth before sowing and after the harvest of crop for analysis. Soil mechanical analysis was done by Gee and Bauder, 1986.

The bulk density was calculated on volume basis as follows.

$$Bulk\ density = \frac{Oven\ dry\ weight\ of\ soil\ (g)}{Field\ volume\ of\ soil\ (cm3)}$$

Soil pH was determined by soil water suspension of 1:2 (Mc Lean, 1982). Soil organic matter (%) was determined by Nelson and Sommers, (1996) method. Total nitrogen in the soil was determined by Kjeldahl method of Bremner and Mulvaney, (1982). Phosphorus was determined by reducing ammonium heptamolybdate complex by ascorbic acid in the presence of antimony potassium tartrate (Murphy and Riley, 1962). The color intensity for P was measured on spectrophotometer at 880-nm. The K was measured by the method of Wright and Stuczynski, 1996 on flame photometer.

Growth characteristics

All growth parameters were recorded at the maturity of crop. The height (cm) of the selected plants was measured with a meter rod. Leaf area (cm^2) was measured by leaf area meter. Chlorophyll content (mg cm^{-2}) of selected plants from each plot was measured according to method of Lichtenthaler and wellburn (1985) with formula:

Ca = 11.75A662 – 2.350A645
Cb = 18.61A645 – 3.960A662

The shoot fresh weight (g) of selected plants from each treatment was recorded with electric balance. To record shoot dry weight weighed plants **(**g**)** were kept in an oven at 65^0C for 24 hours and dry weight was done with electric balance. The root length (cm) was determined with meter rod. The fresh root samples of the collected plants were washed thoroughly and fresh weight (g) was noted with electric balance. The roots were oven dried at 65^0C for 24 hours then root dry weight (g) was taken on electric balance. Numbers of nodules were collected from roots of three selected plants and then were averaged.

Each treatment was harvested and after threshing grain yield was recorded 1t 12% water contents as kg per hectare. Stalk yield (kg ha^{-1}) was calculated as the difference between grain yield and biological yield. Harvest index was calculated by the following formula:

$$H.I\ (\%) = \frac{Grain\ \ yield}{Biological\ yield} \times 100$$

Plant analysis

Plant samples were oven-dried at 65ºC to a constant weight. The samples were ground and screened through 2mm sieve. These processed plant samples (stalk and grains) were analyzed for their N. Total nitrogen (%) in both stalk and grains was determined according to Bremner and Mulvaney (1982) method.

Nitrogen uptake

Nitrogen uptake (kg ha^{-1}) was calculated both in grain and stalk by multiplying concentration of nitrogen with respective yield. Nitrogen uptake in the whole plant was calculated by adding values for grains and yield.

Statistical analysis

Statistical analysis was done in Statistix 8.1 computer software. The treatments mean were compared using (LSD) at 5% level of probability (Steel *et al*., 1997).

Results and Discussion

Pre-sowing soil properties of study site

The pre-sowing properties of study site are given in Table 1. The properties showed that soil was loam and slightly acidic with pH of 6.53. The organic matter was low in these soils. However, available P and K were in marginal range and total N was 0.049%.

Comparative and interactive effects of urea nitrogen, poultry manure and sawdust on growth and yield of soybean

Plant Height

The comparative and interactive effects of urea nitrogen, poultry manure and sawdust on plant height (cm) of soybean are depicted in Table 2. The minimum plant height (18.76 cm) was observed in control and it was similar with SDN100 (21.73 cm). However the percent increase of UN50+SDN25+PM25 and PMN50+SDN50 was 63% and 58% respectively, over control.

The higher plant height in UN_{50}+SDN25+PM_{25} may be attributed to higher nutrient use efficiency by interactive effect of organic amendments with UN. Moreover, SD rate did not show adverse effect of immobilization of nitrogen in integrated treatment. Inorganic N application alone or with organic N augmented plant height significantly (Idris *et al.*, 2001; Singh and Agarwal, 2001) because N plays important role in cell enlargement, expansion and division. The lower plant height with SD could be due to wider C:N ratio of SD and it immobilized the nutrients (Olayinka, 2009).

Shoot fresh weight

The comparison of means (Table 2) indicated the highest shoot fresh weight (80.55g) by UN100 and it was parallel to PMN50+SDN50, UN50+PMN50 and UN50+SDN50. The uses of organic amendments like PM and SD improves the soil physico-chemical properties and ultimately increases of plant growth (Nottidge *et al.*, 2005).

Shoot Dry Weight

The comparative and interactive effects of urea nitrogen, poultry manure and sawdust significantly affected shoot dry weight (g) of soybean (Table 2). The higher shoot dry weight 47.4 g was observed in UN_{100} and it was statistically equal with UN50+ PM25+SDN25 (47.0 g). The percent increase of UN100 and UN50+ PMN25+SDN25 was 21% over control. The SD and PM additions can show higher plant growth with slow release of (Olayinka, 2009).

Root Length

Results (Table 2) showed higher root length of 30.5 cm was UN50+ PMN25+SDN25 followed by UN50+SDN50 (29.7 cm). The percent increase of UN50+ PMN25+SDN25 and UN50+SDN50 was 62% and 58% respectively, over control. The higher root length in UN50+PMN50 and in UN50+ PMN25+SDN25 could be due to aggregated soil structure, more aeration, higher water and nutrient holding capacity, lower bulk density and higher porosity. As organic amendments improves all these soil physical properties. Studies (Moore and Edwards, 2005; Tejada *et al.*, 2006) have shown that PM application in long term experiments improves the soil properties by increase of SOM.

Root Fresh Weight

The percent increase of UN50+PMN50 over control was 58% (Table 2). The minimum root fresh weight (11.7 g) was observed in the control and it was similar with the SDN100 (13.1 g).

The lower root fresh weight in SDN100 is might be due to less root growth because of higher rate of immobilization. The application of sawdust of high C: N ratio into the soil limits available nitrogen and cause inorganic soil N to be immobilized (Myrold, 1998).

Root Dry Weight

The data (Table 2) revealed that compare to control UN100 had 35% higher root dry weight. The minimum root dry weight (7.13g) was observed in the control and it was equivalent to the SDN100 (7.64 g).

Table – 1: Pre-sowing properties of experimental area

Soil properties	Units	Values
Bulk density	g cm^{-3}	1.42
Sand	%	39.4
Silt	%	34.6
Clay	%	26.0
Textural class	Loam	
Soil pH (1:2H_2O)	---	6.53
Organic matter	%	0.81
Total N	%	0.049
Available P	mg kg^{-1}	6.22
Available K	mg kg^{-1}	87.2

Table – 2: Comparative and interactive effects of urea nitrogen, poultry manure and sawdust on the growth of soybean

Treatments	Plant Height (cm)	Shoot fresh weight (g)	Shoot dry weight (g)	Root Length (cm)	Root Fresh Weight (g)	Root Dry Weight (g)
Control (no amendments)	18.76 c	63.46 c	39.3 c	18.77 c	11.7 c	7.13 b
UN_{100}	25.40 abc	80.53 a	47.5 a	25.40 abc	16.8 ab	9.63 a
PMN_{100}	27.23 ab	69.67 bc	42.2 bc	27.23 ab	16.4 ab	9.13 a
SDN_{100}	21.73 bc	67.19 bc	41.1 bc	21.73 bc	13.1 c	7.64 b
UN_{50}+PMN50	23.66 abc	75.07 ab	44.3 ab	29.73 a	18.5 a	9.40 a
UN_{50}+SDN50	26.83 ab	74.27 ab	42.5 bc	26.83 ab	15.9ab	7.85 b
PMN50+SDN50	29.73 a	76.23 ab	39.5 c	23.67 ab	15.8 b	8.98 a
UN_{50}+ PMN25+SDN25	30.50 a	72.70 abc	47.0 a	30.50 a	16.1 ab	9.01 a
LSD	7.05	10.25	37.21	7.05	2.65	0.89

UN= Urea nitrogen; PMN= poultry manure nitrogen; SDN= Sawdust nitrogen
Means sharing same letters are statistically non-significant at $P \leq 0.05$

Leaf Area
The maximum increase in leaf area due to UN50+PMN50 was 40% (Table 3) The minimum leaf area (65.71cm) was observed in control and it was statistically equal to SDN100 (67.59 cm).
The higher leaf area with PM is attributed to its lower C: N ratio and fast nutrient release. Superior LAI under combined applications of organic and inorganic amendments also been reported by Ayoola and Makinde 2009.

Chlorophyll Contents
Results (Table 3) showed that UN50+PMN50 had statistically ($p \leq 0.05$) higher chlorophyll contents (29.2 mg cm^{-2}) and the percent increase of UN50+PMN50 was 58% over control. The minimum leaf area (18.52 mg cm^{-2}) was observed in the control and it was similar with SDN100 (19.40 mg cm^{-2}). Interaction of organic and inorganic amendments had found to increase the chlorophyll contents of plant (Yang *et al.*, 2003).

Dry Matter Yield
Results (Table 3) showed that UN50+ PMN25+SDN25 had statistically higher dry matter yield (2863.7 kg ha^{-1}) and it was similar to UN100 (2848.3 kg ha^{-1}). However, the percent increase of UN50+ PMN25+SDN25 and UN100 is 14% and 13% respectively, over the control. The higher dry matter yield in interactive application of PM, SD and UN showed that saw dust application rate to provide 25 kg N ha^{-1} did not show adverse effect of immobilization during growing period of soybean. The immobilization effect might have been offset by inorganic source of N. There was substantial reduction in the growth and yield when sawdust was applied without initial composting, this agreed with the former work done by Daramola *et al*., (2006).

Grain Yield
Results (Table 3) exhibited that UN100 had statistically higher grain yield (1322.7 kg ha^{-1}) and it was comparable with UN50+PMN50 (1242.0 kg ha^{-1}) and UN50+ PMN25+SDN25 (1222.7 kg ha^{-1}). The increase of UN100, UN50+PMN50 and UN50+ PMN25+SDN25 over control was 51%, 41% and 39% respectively. The higher yield with organic and inorganic integration has increase yield. This could be attributed to formation of favorable soil properties with addition of organic amendments in soil and ultimately higher yield (Ikpe and Powel, 2003; Ano and Agwu, 2005).

Harvest Index

The higher harvest index (31.69%) was observed in UN100 and it was statistically non-significant withUN50+ PMN50 (31.25%) (Table 3). However, the percent increase of UN100 and UN50+ PMN25+SDN25 was 22% and 21% respectively, over the control. Shahzad *et al.*, 2013 reported that the increase in harvest index is correlated with higher nitrogen uptake.

Table – 3: Comparative and interactive effects of urea nitrogen, poultry manure and sawdust on the growth and yield of soybean

Treatments	Leaf Area (cm)	Chlorophyll contents mgcm^{-2}	Dry Matter yield (kg ha^{-1})	Grain yield (kg ha^{-1})	Harvest Index (%)
Control (no amendments)	65.71 b	18.52 b	2516.3 bc	878.0 c	25.87 c
UN_{100}	91.52 a	29.13 a	2848.3 a	1322.7 a	31.69 a
PMN_{100}	87.58 a	25.90 a	2744.0 ab	1144.7 b	29.43 ab
SDN_{100}	67.59 b	19.40 b	2556.7 bc	981.7 c	27.86 bc
UN_{50}+PMN50	92.33 a	29.21 a	2726.3 abc	1242.0 ab	31.25 a
UN_{50}+SDN50	87.12 a	25.15 a	2655.7 abc	1158.7 b	30.44 ab
PMN50+SDN50	81.82 a	25,027a	2452.3 c	1009.7 c	29.15 ab
UN_{50}+PMN25+SDN25	90.88 a	27.680 a	2863.7 a	1222.7 ab	29.89 ab
LSD	11.42	5.32	281.84	132.87	3.08

UN= Urea nitrogen; PMN= poultry manure nitrogen; SDN= Sawdust nitrogen
Means sharing same letters are statistically non-significant at $P \leq 0.05$

Comparative and interactive effects of urea nitrogen, poultry manure and sawdust on nitrogen concentration and uptake

Seed Nitrogen

The UN100 had statistically ($p \leq 0.05$) higher seed nitrogen (4.60%) followed by UN50+ PMN25+SDN25 (4.41%) (Table 4). However, the percent increase of UN100 and UN50+ PMN25+SDN25 was 19% and 14% respectively, over the control. The minimum seed nitrogen (3.87%) was observed in control followed by SDN100 (4.06%).

Stalk Nitrogen

Results (Table 4) revealed that UN100 had statistically higher stalk nitrogen (95.72%) and it was equal with UN50+ PMN50 (89.54%).The increase of stalk nitrogen by UN_{100} and UN_{50}+ PMN50 was 54% and 44% respectively, than control. The minimum stalk nitrogen (62.125%) was observed in control and it was similar with SDN100 (64.28%) and PMN50+SDN50 (64.58%).

Grain N uptake

Statistically higher N uptake (60.84 kg ha^{-1}) was recorded in UN100 followed by PMN50+ SDN50 (55.24 kg ha^{-1}) (Table 4). The UN100 and PMN50+SDN50 had increase of 79 kg ha^{-1} and 63 kg ha^{-1}grain N uptake respectively, over the control. The minimum grain N uptake of 33.93% was observed in control and it was similar with SDN100 (39.82 kg ha^{-1}).

Stalk N uptake

Results (Table 4) indicated that UN100 had statistically higher stalk N uptake of 95.5 2 kg ha^{-1} and it was followed by UN50+ PMN50 (89.54 kg ha^{-1}). The lowest stalk nitrogen (62.13 kg ha^{-1}) was observed in control and it was similar with SDN100 (64.58 kg ha^{-1}) and PMN50+SDN50 (64.58 kg ha^{-1}). Cheatham, 2003 reported that the treatment PM gave the highest

N uptake in corn stalks and no significant difference was found in N uptake in corn stalks between PM and UN.

Total N uptake

The Results (Table 4) revealed that UN100 had statistically higher stalk N uptake (156.55 kg ha^{-1}) and it was at par with UN50+ PMN50 (144.78 kg ha^{-1}). Though, the percent increase of UN100 and UN50+ PMN50 was 63% and 51% respectively, over the control. The comparable total N uptake by integrated application of UN50+PMN50 and UN50+PMN25 +SDN25 suggests adding organic amendments at varying rates of N and dependence on chemical fertilizer can be reduced. Nitrogen and phosphorus are mainly released nutrients from organic amendments after decomposition (Paul, 2007). Moreover, lower total N uptake by SDN100 was due to the high C: N ratio of sawdust, which had limited available N and caused inorganic soil N to be immobilized (Myrold, 1998).

Table – 4: Comparative and interactive effects of urea nitrogen, poultry manure and sawdust on nitrogen concentration and uptake

Treatments	Seed Nitrogen (%)	Stalk Nitrogen (%)	Grain N uptake (kg ha^{-1})	Stalk N uptake (kg ha^{-1})	Total N uptake (kg ha^{-1})
Control (no amendments)	3.87 d	62.13 c	33.93 e	62.13 c	96.05 c
UN100	4.60 a	95.72 a	60.84 a	95.52 a	156.55 a
PMN100	4.43 ab	82.48 ab	50.61 b	82.48 ab	133.07 b
SDN100	4.06 cd	64. 28 a	39.82 de	64.58 c	104.40 c
UN50+PMN50	4.13 bcd	89.54 ab	41.88 cd	89.54 ab	144.78 ab
UN50+SDN50	4.25 abc	78.64 bc	49.19 ab	78.64 bc	127.83 b
PMN50+SDN50	4.13 bcd	64.58 c	55.24 ab	64.28 c	106.17 c
UN50+ PMN25+SDN25	4.41 abc	88.59 ab	53.81 ab	88.49 ab	142.29 ab
LSD	0.37	16.66	7.81	16.62	18.51

UN= Urea nitrogen; PMN= poultry manure nitrogen; SDN= Sawdust nitrogen
Means sharing same letters are statistically non-significant at $P \leq 0.05$

Comparative and interactive effects of urea nitrogen, poultry manure and sawdust on soil properties after soybean harvest

Soil pH

The effects of treatments on soil pH are statistically non-significant (Table 5). However the percent increase of PMN100, PMN50+SDN50 and UN50+SDN25+PMN25 over initial pH contents were 1.84%, 1.68% and 1.53% respectively. The increase in soil pH with PM and in integrated treatments of PM with organic and inorganic amendments might be due to decrease of the exchangeable Al toxicity. The increase in soil pH and decrease of soil exchangeable acidity following application of manure can be attributed to the release of organic acids (by mineralization of manure), which in turn may have inhibited Al content in the soil through chelation (Onwonga *et al*., 2008).

Soil Organic Matter

Statistically higher organic matter (0.84%) was found in UN50+ PMN25+SDN25, PMN50+SDN50 and UN50+SDN50 (Table 5). The minimum organic matter (0.78%) was observed in control. Compare to initial OM contents, the increase of UN50+ PMN25+SDN25, PMN50+SDN50 and UN50+SDN50 was 3.70%. In our study the higher O.M contents in integrated treatments of organic and inorganic amendments are in agreement with earlier studies. By using PM over a long period of time the soil OM would increase (Tejada *et al*., 2006). Similarly, Bulmer (2000) indicated sawdust application showed higher organic matter level compare to untreated soil.

Soil Nitrogen

The Results (Table 5) indicated the minimum nitrogen (0.047%) in control and it was similar to SDN100 (0.048%). The percent increase of UN50+PMN50 and PMN100, UN50+ PMN25+SDN25 and UN100 was 12.24%, 8.16%, 6.12% and 4.08% respectively, over initial soil N contents. However, control, SDN100 and PMN50+SDN50 showed decrease over initial soil N contents. The higher total N contents in treatments where organic materials such as sawdust and PM were added together with N fertilizer are in agreement with other Paustian *et al*., 1992.The decline in total N in SD and PM+SD might be due to immobilization of inorganic N in saw dust (Myrold, 1998).

Soil Phosphorus

The Results (Table 5) showed that UN50+PMN50 had significantly higher phosphorus (6.32 mg kg^{-1}) contents and the minimum phosphorus (5.12 mg kg^{-1}) was observed in control. The increase of P contents of UN50+PMN50, PMN100, UN50+ PMN25+SDN25 and UN100 was 1.61%, 1.29%, 1.13% and 0.80% respectively, over initial P contents. The higher P contents in treatment PM and in integrated organic and inorganic amendments could be attributed to higher N and P contents of PM (Olayinka, 2009).

Table – 5: Comparative and interactive effects of urea nitrogen, poultry manure and sawdust on soil properties after soybean harvest

Treatments	pH	OM (%)	Total N (%)	Soil Phosphorus (mg kg^{-1})
Control (no amendments)	6.55 ns	0.78 c	0.047 b	5.12 d
UN100	6.56	0.83 bc	0.051 ab	6.27 a
PMN100	6.65	0.82 ab	0.053 ab	6.30 a
SDN100	6.54	0.82 ab	0.048 b	6.11 c
UN50+PMN50	6.56	0.83 ab	0.055 a	6.32 a
UN50+SDN50	6.56	0.82 a	0.050 b	6.18 b
PMN50+SDN50	6.64	0.84 a	0.048 b	6.17 bc
UN50+ PMN25+SDN25	6.62	0.84 a	0.052 ab	6.29 a

UN= Urea nitrogen; PMN= poultry manure nitrogen; SDN= Sawdust nitrogen
Means sharing same letters are statistically non-significant at $P \leq 0.05$

Conclusion

The interactive application of UN50+ PMN25+SDN25 gave statistically similar yield as UN100. The higher organic matter was found in UN50+ PMN25+SDN25. Sawdust did not decompose totally in one growing season so higher impact of interactive effect of PM and SD with UN is not pronounced in all parameters. The use of SD and PM has the potential to reduce need for inorganic fertilizers as both organic amendments are locally available.

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