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Research Article

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Effect of organic manuaring and inorganic fertilization on soil health and crop yield in soybean (*Glycinc max* L.) onion (*Allium cepa*) cropping system

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Summary

The field experiments were carried out continuously for two years, at cropping system research farm, at Vasantrao Naik Marathwada Agricultural University, Parbhani to study the effect of organic and inorganic on soil health and crop yield of soybean (*Glycin max*)- onion (*Allium/ cepa*) *Kharif* and summer season. The experiments were conducted in Randomized Block Design with seven treatments. Among the different combinations of the tow application of 50% N through FYM + inorganic sources of micro nutrients (T_1) recorded significantly beneficial effect on crop yield of soybean onion cropping system. The porosity, infiltration rate, soil pH, electrical conductivity, calcium carbonate and organic carbon observed improved with application of FYM + vcrmicompost + *Neem* seed cake (T_2) as an treatments.

Key words : Cropping system, Organic, Inorganic, Soil health, Soybean, Onion

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Introduction

Soybean is the major oil seed crop next only to ground nut and mustard. India ranks fifth in the word in area and production (6.6 million metric tonnes, FAO 2006), but productivity is very low (less than 1 tonn^{-1}) and for behind the other soybean producing countries. Onion is largest vegetable produced and consumed not only in India but also in the world. India has largest area about 4 Lakh ha (20%) followed by China (197.93 Lakh MT) against India (55 Lakh MT) due to higher productivity in china (FAO, 2006). Soybean ofters numerous advantages to the farmers. In addition to nitrogen fixation ability and soil fertility improvement, soybean has excellent rational effect on almost all crops currently grown in Maharashtra state. Legume oil seed cropping system is given greater emphasis in India agriculture because of increasing evidence that this practice gives stabilized yield advantage easily. Normally both crops *i.e.* soybean and onion are grown as major *Kharif* and summer crops, respectively for quality evolution of vegetable grown under organic and inorganic production systems (Rathore *et al.*,2014). Nutrient uptake N, P and K by spinach at final harvest was found to be significantly highest with 100 per cent organic manuses (Rani and Padmaja, 2014). It is comparative study of biofertilizers and organic manures play an important role in growth, yield and production of

Fenugreek (Chudhary and Tehlan, 2014). (Rathore *et al.*, 2014) also reported quality evalution of vegetables grown under organic and inorganic production system.

Therefore, the present investigation on the effect of organic manure and inorganic fertilizer of soil health and the productivity was under taken.

Resource and Research Methods

The field experiments on soybean-onion cropping system were conducted during *Kharif* and summer seasons on a typic Haplluster at Parbhani.

The experiment was laid out in Randomized Block Design with four replicatins. Seed inocculation was done of *Rhizobium japonicum*, *Azatobacter* and PSB @ 250 g biofertilizer culture each 10g kg^{-1} seed as seed treatment before sowing.The recommended dose of inorganic fertilizers was applied @ 30:60:30 ($N:P_2O_5$: K_2O kg ha^{-1}) for soybean and 100: 50: 50 ($N:P_2O_5$: K_2O kg ha^{-1}) for onion, the fertilizers used were urea, single superphosphate and muriate of potash. Soybean MAUS-71 and onion 'AFDR' were raised during *Kharif* and summer season, respectively with recommended package of practices. Sowing of soybean was done in the month of July and harvested in October, where as an onion was sown in December in both the years and harvested in the April. The treatment details are follows.

T_1 –50 % RDF NPK + 50% N through FYM + inorganic sources of micronutrients as per soil test.

T_2 – Different organic sources each equivalent to 1/3 of recommended N through (FYM + Vermicompost + *Neem* seed cake)

T_3–T_2 + inter cropping of maize and garlic.

T_4–T_2 + stale bed preparation (agronomic practices for weed control)

T_5–50% N through FYM+*Rhizobium* and *Azatobacter* culture + rock phosphate to substitute the P requirement of crops + phosphate solubulizing bacterial culture (PSB).

T_6 – T_2+ *Rhizobium*, *Azatobacter* and PSB culture.

T_7–100% NPK + secondary and micronulent based on soil test.

The soil samples were collected after harvesting of soybean – onion crops after 2 years of study for analysis of available NPK and S and DTPA extractable micronutrients (Fe, Zn and Cu) as per standard procedures. The plot wise yields of both the crops for both years were recorded.

For physical properties bulk density was determined by core method and infiltration by double ring infiltrometer method (Black, 1965). The soil reaction *viz.*, soil pH was determined in (1:2.5) soil water suspension using digital pH meter and electrical conductivity was estimated in (1:2.5) soil: water ratio using conductivity bridge (Jackson, 1967). Organic carbon was estimated by rapid titration method (Jackson, 1967). Where as organic carbon in manures was determined by dry combustion method (Chopra and Kanwar, 1980). Free calcium carbonate was estimated by volumetric method (Puri, 1949) and DTPA extracted Fe, Mn, Zn and Cu were determined by using AAS (Lindsay and Norvel, 1978). Before harvesting five plants were randomly selected from the net plot and used for chemical analysis after oven drying. N was determined by Microckjeldahls method (Tondon, 1993), phosphorus by vandomolybdate phosphoric acid yellow colour method, potassium by extract on flame photometer (Jackson, 1967) and oil content of soybean by nuclear magnetic resonance (NMR) (Willard *et al.*, 1986). The nutrient uptake worked out by multiplying the nutrient concentration in plant grain with respective yields.

Research Findings and Discussion

The biological yield of soybean and onion, the result presented in Table 1 indicated that the biological yield differences were found significant due to the organic treatments, FYM + vermicompost +*Neem* seed cake with phosphate solubulizing bacteria and *Rhizabium* culture (T_5). Thus, application of combined use of organic manuare and inorganic fertilizers gave maximum grain yield of soybean and bulb yield of onion. It was interesting to note that the organic with PSB. treatement inoculated with PSB and *Rhyzobium* recorded higher yield over uninoculated (Naik *et al.*,2015 and Thakur *et al.*, 2011) in onion bulb. However, better improvement in yield of a rape seed was established when inorganic fertilizer and FYM were integrated together (Basumatary and Talukdar, 2011). In the similar manner, significantly higher yield attributed to higher and vigrous growth of onion (Nadeshwar *et al.*, 2013).

Soil physical condition and physical properties :

The result given in Table 2 indicated the significant decrease in bulk density with addition of organic treatment due to addition of organic matter and the significant increase in porosity were noticed in treatment T_6 (FYM + vermicompost + *Neem* seed cake + biofertilizer).

Table 1 : Effect of organic manuring and inorganic fertilization of grain and straw yield of soybean and onion bulb

Treatments	Yield (kg ha^{-1})										
	Soybean		Onion		O.C	After harvest of onion Available nutrients (kg ha^{-1})				DTPA	
	Grain	Straw	Bulb	Straw	(g kg^{-1})	N	P	K	S	Fe	ZN
T_1 – 50 % RDF NPK + 50% N through FYM + inorganic sources of micronutrients as per soil test	2349	3198	29176	2460	6.27	200.55	13.82	356.25	12.89	8.81	0.75
T_2 – Different organic sources each equivalent to 1/3 of recommended N through (FYM + Vermicompast + *Neem* seed cake)	1809	2468	19469	1545	6.43	187.64	11.74	331.15	10.82	5.32	0.64
T_3 –T_2 + inter cropping of maize and garlic	1633	1803	12715	1065	6.43	172.73	12.42	327.35	10.13	5.17	0.69
T_4 – T_2 + stale bed preparation (agronomic practices for weed control)	1683	2281	20322	1635	6.30	170.89	12.03	331.93	10.78	5.83	0.65
T_5 – 50% N through FYM + *Rhizobium* and *Azatobacter* culture + rock phosphate to substitute the P requirement of crops + phosphate solulbulizing bacterial culture (PSB)	1524	2041	17388	1380	5.87	163.21	12.51	326.88	10.96	5.96	0.60
T_6 –T_2 + *Rhizobium*, *Azatobacter* and PSB culture	2000	2727	22489	1815	6.73	199.63	13.19	350.81	11.90	6.88	0.70
T_7 – 100% NPK + Secondary and micronutrients based on soil test	2095	3070	26403	2200	5.47	159.12	13.29	321.19	10.5	5.06	0.59
S.E. $\pm$	103.41	83.05	778.15	128.72	0.17	2.32	0.34	2.90	0.21	0.26	0.03
C.D. (P=0.05)	306.82	246.32	2308.42	381.92	0.51	6.87	1.01	8.49	0.61	0.78	0.10

Table 2 : Effect of organic manuring and inorganic fertilization of soil physical and soil physico-chemical properties after harvest of soybean-onion cropping system

Treatments	Soil physical properties						Soil chemical properties							
	Soybean –onion						Soybean –onion							
	Bulkdensity (Mgm^{-3})		Soil porosity (%)		Infittration rate (cm hr^{-1})		pH		EC		O.C		Calcium carbonate	
T_1 – 50 % RDF NPK + 50% N through FYM + inorganic sources of micronutrients as per soil test	1.23	1.20	53.59	54.72	1.70	2.55	8.07	8.00	0.32	0.31	6.10	6.27	66.67	66.51
T_2 – Different organic sources each equivalent to 1/3 of recommended N through (FYM + Vermicompast + *Neem* seed cake)	1.18	1.17	55.48	55.85	1.90	2.60	8.09	8.01	0.31	0.30	6.23	6.43	66.32	66.30
T_3 –T_2 + inter cropping of maize and garlic	1.21	1.18	54.72	55.48	1.85	2.55	8.06	7.92	0.28	0.28	6.21	6.43	66.40	66.52
T_4 – T_2 + stale bed preparation (agronomic practices for weed control)	1.19	1.16	55.10	56.23	1.80	2.60	8.02	7.94	0.26	0.24	6.08	6.30	66.74	66.72
T_5 – 50% N through FYM + *Rhizobium* and *Azatobacter* culture + rock phosphate to substitute the P requirement of crops + phosphate solulbulizing bacterial culture (PSB)	1.16	1.13	55.85	57.36	1.85	2.65	8.07	7.93	0.29	0.27	5.73	5.87	66.80	66.14
T_6 – T_2 + *Rhizobium*, *Azatobacter* and PSB culture	1.17	1.12	56.23	57.74	1.90	2.70	7.80	7.75	0.24	0.23	6.54	6.73	66.46	66.22
T_7 –100% NPK + Secondary and micronutrients based on soil test	1.27	1.26	52.08	5246	1.60	2.45	8.26	8.31	0.37	0.38	5.40	5.47	66.68	66.81
S.E. $\pm$	0.02	0.03	0.33	0.63	0.06	0.07	0.08	0.10	0.003	0.007	0.24	0.17	0.31	0.23
C.D. (P=0.05)	0.07	0.09	0.98	1.86	0.17	0.19	0.22	0.30	0.011	0.023	0.72	0.51	NS	NS

NS= Non-significant

Decrease in bulk density with organic treatment addition to organic matter increase porosity of soil.Thakur *et al.* (2011) observed decrease in bulk density continues incresitng the organic matter combinations. It was further observed the infiltration rate was increased after the harvest of both the crops. The treatment T_6 (FYM + vermicompert + *Neem* seed cake + biofertilizer) recorded highest infiltration rate during both the years.The increase in value of infiltration rate might be due addition and residual effect of treatments and summer season after harvest of onion. The positive impact of continues use of inorganic fertilizer and organic manures on soil properties and productivity was observed under soybean-wheat intensive cropping (Thakur *et al.*, 2011). Similar results were reported by Bhardwaj *et al.* (2010) for yield and quality of tomato and French bean crops. Earlier Elayaraja and Singaravel (2011) reported increasing yield of groundnut.

Soil physico-chemical properties :

The pH of soil was significantly decreased from initial level. The lowest soil pH was recorded with the treatment T_6 (FYM+ vermicomport + *Neem* seed cake + biofertilizer) after soybean – onion crops during both the years of experimentation. Lower value for soil pH was recorded due to combined application of organics and inorganics. Pareek and Yadav (2011) found significantly decrease pH with organic manuring. As the

Table 3 : Effect of organic manure and inorganic fertilizer on concentration of nitrogen, phosphorus and potassium in soybean onion

Treatments	Concentration (%)											
	Soybean grain						Onion bulb					
	I Yr			II Yr			I Yr			II Yr		
	N	P	K	N	P	K	N	P	K	N	P	K
T_1 – 50 % RDF NPK + 50% N through FYM + inorganic sources of micronutrients as per soil test	6.79	0.569	1.92	6.89	0.549	1.81	0.384	0.100	0.370	0.344	0.096	0.291
T_2 –Different organic sources each equivalent to 1/3 of recommended N through (FYM + Vermicompast + *Neem* seed cake)	7.14	0.599	2.05	7.17	0.589	1.92	0.426	0.104	0.371	0.410	0.102	0.341
T_3 – T_2 + inter cropping of maize and garlic	7.19	0.579	2.08	7.21	0.580	1.98	0.434	0.116	0.360	0.384	0.104	0.350
T_4 – T_2 + stale bed preparation (agronomic practices for weed control)	7.23	0.589	2.13	7.26	0.569	1.94	0.450	0.114	0.342	0.454	0.108	0.330
T_5 – 50% N through FYM + Rhizobium and *Azatobacter* culture + rock phosphate to substitute the P requirement of crops + phosphate solulbulizing bacterial culture (PSB)	71.5	0.649	2.10	7.12	0.639	1.98	0.406	0.128	0.370	0.426	0.130	0.391
T_6 – T_2 + Rhizobium, *Azatobacte*r and PSB Culture	7.31	0.619	2.17	7.29	0.620	2.00	0.462	0.118	0.391	0.462	0.106	0.372
T_7 _ 100% NPK + Secondary and micronutrients based on soil test	6.68	0.550	1.89	6.75	0.509	1.78	0.342	0.094	0.331	0.322	0.084	0.280
S.E.±	0.22	0.04	0.13	0.17	0.14	0.08	0.06	0.02	0.02	0.04	0.02	0.04
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS= Non-significant

application FYM + vermicompost + *Neem* seed cake + biofertilizer (T_6) observed significant decrease in EC values. There was slightly decrease in electrical conductivity of soil with combined application of organics and inorganics. Sharma *et al*. (2013) also obtained in their study that the EC of soil decreased significantly with increasing level of FYM.

Concentration and nutrient uptake :

The data shown in Table 3 on NPK concentration and nutrient uptake in soybean grain as influenced by inorganic fertilizer and organic manures alone and in combination indicated that there was non-significant variation in NPK concentration. The maximum NPK concentration in soybean grain recorded with T_6 (FYM + vermicompost + *Neem* seed cake + biofertilizer). Increase in NPK concentration was relatively higher with combination of different organic sources than inorganic fertilizer alone. Also the result on NPK concentration in onion bulb as affected by organic manures and inorganic fertilizers shown in Table 3. The result revealed that the N,P and K content in bulb were statistically non-significant.

Nitrogen uptake:

Maximum uptake of nitrogen was recorded with integrated nutrient management (T_1), it may be attributed to efficient utilization of nutrient treatment in terms of increasing N uptake by soybean and onion shown in Table 4.

Rani and Padmaja (2014) also reported the 100% FYM treatment resulted in higher NPK uptake in maize spinach cropping system. Organic manures coupled with NPK fertilizer recorded significantly highest N uptake. Similarly integrated nutrient management application of organic fertilizer with FYM significantly increased the N, P and K by rice- pea cropping system (Singh *et al.,* 2011).

Phosphorus uptake:

Table 4 shows that the highest P uptake was

Table 4 : Effect of organic manure and inorganic fertilizer on NPK uptake in soybean-onion

Treatments	Total nutrient uptake (kg ha^{-1})											
	Soybean						Onion					
	I Yr			II Yr			I Yr			II Yr		
	N	P	K	N	P	K	N	P	K	N	P	K
T_1 – 50 % recomand NPK + 50% N through FYM + inorganic sources of micronutrients as per soil test	180.18	21.87	98.05	191.58	22.50	97.51	126.43	33.08	122.67	162.35	44.60	134.51
T_2 –Different organic sources each equivalent to 1/3 of recommended N through (FYM + Vermicompast + Neem seed cake)	139.72	17.37	76.50	155.36	18.56	79.89	98.14	24.62	87.29	121.99	30.95	102.64
T_3 –T_2 + inter cropping of maize and garlic	142.25	17.07	79.43	164.39	18.81	84.47	117.27	30.31	100.61	130.88	36.44	117.78
T_4 – T_2 + stale bed preparation (agronomic practices for weed control)	155.57	18.08	86.05	146.13	16.66	74.62	99.30	26.41	78.20	137.06	34.34	104.81
T_5 – 50% N through FYM + Rhizobium and *Azatobacter* culture + rock phosphate to substitute the P requirement of crops + phosphate solulbelizing bacterial culture (PSB)	129.75	17.47	69.14	131.35	17.30	67.92	83.10	26.13	75.98	112.98	34.59	105.76
T_6 –T_2 + Rhizobium, *Azatobacter* and PSB culture	173.47	21.70	92.78	175.25	21.67	92.35	124.91	30.03	108.89	156.70	37.35	130.35
T_7 – 100% NPK + Secondary and micronutrients based on soil test	173.58	20.89	95.89	175.61	19.58	89.48	85.01	28.21	97.36	137.15	36.62	117.72
S.E.±	5.50	1.18	4.10	6.63	1.12	3.01	5.50	1.45	1.77	9.90	1.80	4.07
C.D. (P=0.05)	16.32	3.50	12.16	19.67	3.32	8.94	16.32	4.29	5.27	29.37	5.35	12.04

obtained in treatment receiving combined application of NPK fertilizers, FYM, micronutrients, vermicompost, *Neem* seed cake than the other treatments. However, the combined application was found superior which further helped to increase availability of phosphorus in soil resulting in its uptake by both the crops due to better availability of phosphorus in crop root zone, its solubulization caused by the organic acids produced from decaying organic matter and increased uptake by soybean root due to their association with micorhyzal filament increasing the ascribing area of roots.

Similar observation on P uptake by maize-spinach cropping system with integrated nutrient management was observed by Rani and Padmaja (2014). The higher available pool of phosphorus from various organic materials had contributed to improvement of P uptake by onion reducing fixation of P in soil. The superiority of combined application of organics and inorganic sources resulting in increased P uptake for the succeeding crop. Similar results were reported by Waghchaure (2004).

Potassium uptake:

Among the organic sources T_6 was superior, this could be explained on the basis of better availability of K receiving the combined application of NPK fertilizer, FYM, biofertilizers, vermicrompost, *Neem* seed cake with $ZnSO_4$ which recorded highest K uptake and was found at par with T_7 (100% NPK + secondary and micronutrient based on soil) and T_6 (FYM + vermicrompost + *Neem* seed cake + biofertilizer) recorded uptake of higher K by onion with organic treatment (T_6) due to partly acidulation effect of organic manures and microflora on K bearing manures present in the soil. Further K is dissolved in soil solution and efficiently absorbed by crops. Similar observation was recorded by Rani and Padmaja (2014) in maiz-spinach cropping system. Brar *et al*. (2010) also observed yield quality and nutrient uptake by sunflower.

Conclusion:

On the basis of field study it may be concluded that the various organic treatment combinations, 1/3 dose of N through FYM+ vermicrompost + *Neem* seed cake in addition to biofertilizer *Rhizobium japonicum* + *Azatobacter* + PSB) proved its superiority over other organic treatment combinations on physical and chemical properties of soil. However, inorganic treatment proved superior over organics only in nutrient uptake by the plants and yield of soybean onion. Application of recommended dose of fertilizers along with 50 per cent N through FYM was found to improve the productivity and soil health.

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