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Yield, Quality of Soybean (*Glycine Max*)-Onion (For Seed) (*Allium Cepa*) and residual soil fertility as influenced by integrated nutrient management

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Abstract
A field experiment was carried out at Post Graduate Institute Research Farm, Central Campus, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (MS) during 2014-15 and 2015-16 to study the effect of integrated nutrient management on growth and yield on soybean-onion (for seed) crop sequence. The experiment was laid out in split plot design with three replications. The treatments consisted of combinations of 5 nutrient sources in main plots were applied to *kharif* soybean and 3 fertilizer levels in sub plot treatments to onion (for seed) The residual effect of the integrated nutrient sources applied to *kharif* soybean was tested in the succeeding *rabi* onion (for seed). Three fertilizer levels as sub plot treatments to onion (for seed). Application of 100 % recommended dose of fertilizer (RDF) to preceding crop reported significantly higher values for growth and yield attributes, seed yield (25.86, 27.5 q ha^{-1}) in soybean. The succeeding crop of onion (for seed) too showed a similar trend gross and net monetary returns and benefit : cost ratio in *rabi* onion (for seed), however, it was found at par with 50 % recommended dose of nitrogen (RDN) through chemical fertilizers (CF) + 50% recommended dose of nitrogen (RDN) through vermicompost (VC) followed by the treatment 50 % recommended dose of nitrogen (RDN) through chemical fertilizers (CF) + 50 % RDN through farmyard manure (FYM) during both the years. Among the integrated nutrient sources higher values observed with application of 50 % RDN through chemical fertilizers (CF) + 50 % RDN through vermicompost (VC) followed by 50 % RDN through chemical fertilizers (CF) + 50 % RDN through farmyard manure (FYM). Among fertilizer levels to succeeding *rabi* onion (for seed) significantly higher values registered for growth and yield attributes, seed yield ((5.05, 5.45 q ha^{-1}), gross and net monetary returns and benefit: cost ratio with the application of 125% RDN through chemical fertilizers (CF) over 75 % RDN through chemical fertilizers (CF) and at par with 100% RDN through chemical fertilizers (CF) during both the years. After two years completion it was concluded that, combined application of 50% RDN (25 kg ha^{-1}) through chemical fertilizers + 50% RDN through vermicompost (19.5 t ha^{-1}) or farmyard manure (46 t ha^{-1}) to *kharif* soybean followed by 100 per cent RDN (100 kg ha^{-1}) through chemical fertilizers to *rabi* onion (for seed) along with recommended dose of phosphorus and potassium to both the crops is necessary for getting higher yield in soybean-onion (for seed) crop sequence and also markedly improved the oil content in soybean. Use of FYM and VC helped in maintaining soil fertility and rhizospheric microbial population.

Keywords: Nutrient sources, recommended dose of fertilizer (RDF), resisual effect, FYM, VC, NC Soybean, onion seed

Introduction
Soybean (*Glycine max (L.) Merrill*) with its 40-42% protein and 20-22% oil has already emerged as one of the major oilseed crop in India. In spite of its high yield potential (4.5 tonne/ha), soybean productivity is much less in India (0.95 tonne/ha) than the world average of 2.3 tonne/ha (FAI, 2006). Among the factors responsible for low productivity, inadequate fertilizer use and emergence of multiple-nutrient deficiencies due to poor recycling of organic sources and unbalanced use of fertilizers particularly micro-nutrients are important. Soybean generally grown with inadequate quantity of organic and inorganic sources of plant nutrients has not only deteriorated soil health but also resulted in poor productivity of the crop. Due to continuous growing of legumes, regular application of P and N fertilizers, the native micro-nutrient content in soils often becomes inadequate (Singh et al., 2008) for crop. Integration of inorganic fertilizers, organic manures and biological sources and their efficient management has shown promise in not only sustaining the productivity and soil health but also in meeting part of crops nutrient requirement. Organic manures provide a good substrate for the growth of microorganisms and maintain a favourable nutritional balance and soil physical properties (Maheshbabu *et al*., 2008). However, meager information is available on the combined use of Rhizobium, farmyard manure and micro-nutrients with recommended fertilizers in many crops including soybean. Good seed is the basis for any crop production. The seeds which are

produced properly give uniform germination, rapid root and shoot growth and reduced weed. Onion is grown for seeds. Onion seed is poor in keeping quality and loose viability within short period hence it is necessary to produce in every year and use the same for bulk production. The area under onion cultivation is constantly increasing every year to meet the increasing demand of domestic as well as foreign market. Out of total seed requirement only 20 % has been made available from the organize sector and the rest 80 % is met from the farmers own seed. These leads to production of low quality seed therefore, it is necessary to expand area under seed production. The inclusion of legume in cropping sequence is one of the important component of system for saving of fertilizers which are now a days costly inputs. Integrated nutrient management plays vital role in improving soil fertility and yield potential of crops through optimization of benefits from all possible sources in an integrated manner i.e. use of organic and inorganic fertilizers, such practice is not only achieved sustained production and productivity but also economical and ecofriendly. Significant contribution has been made by many research workers on integrated nutrient management in respect of soybean and onion seed production crop alone; however, very meagre work has been done. Keeping these points in view a field experiment was carried out.

Materials and Methods

A field experiment was carried out at Post Graduate Institute Research Farm, Central Campus, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahemadnagar (MS) during 2014-15 and 2015-16. Soil of the experimental plot was clayey in texture analyzing low in available nitrogen (226.12 kg ha^{-1}), medium in available phosphorus (18.20 kg ha^{-1}) and high in potassium content (358.33 kg ha^{-1}). Total soluble salt content in soil (Electrical conductivity) was normal (0.21 dSm^{-1}), the soil was moderately alkaline in reaction (p^H 8.19) and the corresponding numerical values for bulk density and maximum water holding capacity are 1.34 mg m^{-3} and 32.46 per cent, respectively. The experiment was laid out in split plot design with three replications. The main plot treatments were applied to *kharif* soybean comprised of five sources *viz.*, T_1- 100 % Recommended dose of fertilizer (RDF), T_2- 50 % recommended dose of nitrogen (RDN) through chemical fertilizer (CF) + 50 % recommended dose of nitrogen (RDN) through Farmyard manure (FYM), T_3- 50 % recommended dose of nitrigen (RDN) through chemical fertilizer (CF) + 50 % recommended dose of nitrogen (RDN) through Vermicompost (VC), T_4- 50 % recommended dose of nitrogen (RDN) through chemical fertilizer (CF) + 50 % recommended dose of nitrogen (RDN) through Neem cake (NC), T_5- 25 % recommended dose of nitrogen (RDN) through chemical fertilizers (CF) + 25 % recommended dose of nitrogen (RDN) through Farmyard manure (FYM) + 25 % recommended dose of nitrogen (RDN) through vermicompost (VC) + 25 % recommended dose of nitrogen(RDN) through Neem cake (NC). The residual effect of the integrated nutrient sources applied to *kharif* soybean was tested in the succeeding *rabi* onion (for seed). Three fertilizer levels as sub plot treatments to onion (for seed) which comprised *viz.*, F_1- 75 % RDN through chemical fertilizer, F_2-100 % RDN through chemical fertilizer, F_3- 125 % RDN through chemical fertilizer. As per the treatments, organic manures were applied 15 days before sowing and incorporated through land preparation in the soil; and the nutrient levels of recommended dose of fertilizer were applied broadcast and incorporated into the soil during final seed bed preparation. Urea, single superphosphate and muriate of potash were used as sources of N, P and K respectively for supplying the levels RDF. Soybean ('JS-335') was sown @ 75 kg/ha in 30 cm rows during the second fortnight of July in all the 2 years of experimentation. The seeds were treated with cultures of *rhizobium* (*Bradyrhizobium japonicum*) and phosphate solubilizing bacteria (PSB) (*Pseudomonas striata*) before sowing. After emergence of seedlings, these were thinned manually to maintain a plant population of 0.33 All the growth and yield parameters were recorded at physiological maturity (84 DAS), whereas observations on the nodule numbers and their biomass were recorded at flowering and the crop was manually harvested, threshed and seed yields were recorded. After the harvest of soybean, the land was harrow million/ ha and levelled without disturbing the lay-out. The recommended dose of fertilizer of onion (for seed) (100-50-50 kg N-P-K kg/ha) in the form of urea, single superphosphate and muriate of potash was given uniformly to all the plots. Onion bulb ('Phule samarth') was planted in 60 cm rows using a bulb rate of 2700 q/ha in the second fortnight of December in all the years, and the crop was raised with normal agronomic practices. All the growth and yield parameters were recorded at physiological maturity (90 DAS). The crop was manually harvested, threshed and the yield was recorded. The soil samples were collected from each plot after the harvest of onion (for seed), after 2 years of cropping system, at 0-30 cm depth and analyzed using standard procedures. The data recorded were analyzed as per analysis of variance technique for split plot design and presented as mean data of 2 years. The protein and oil content were analyzed NIR spectrometer. Microbial population (Bacteria, fungi and Actinomycetes count) were determined using serial dilution technique. Since data followed the homogeneity test, pooling was done over the seasons and mean data are given.

Results and Discussion

Performance of soybean

The various growths and yield attributes of soybean *viz*., plant height, number of pods per plant number of seeds per pod, seed weight per plant (g) 100 seed weight (g) were recorded significantly maximum with the application of 100 % recommended dose of fertilizer (RDF) (Table 1) than rest of treatments and it was at par with 50 % RDN through CF + 50 % RDN through VC and 50 % RDN through CF + 50 % RDN through FYM. Among integrated nutrient sources application with 50 % RDN through CF + 50 % RDN through VC noted maximum growth attributes followed by 50 % RDN through CF + 50 % RDN through FYM during both the years. Application of 100 % RDF fulfilled the nutrient requirement at early growth stage while FYM and VC facilitated crop at later stages by providing continuous and uniform supply of nutrient, whereas the number of nodules and their dry weight were maximum with application of 50 % RDN through CF + 50 % RDN through VC followed by 50 % RDN through CF + 50 % RDN through FYM than rest of treatments (Table 1). This performance may be attributed to improved soil fertility and microflora activity in the rhizosphere with the application of organic sources of nutrients and RDF. (shivkumar and Ahlawat, 2008). This performance may be attributed to improved soil fertility and microflora activity in the rhizosphere with the application of organic sources of nutrients and RDF.

Application of 100 % RDF to soybean produced significantly higher number of pods/plant, number of seeds plant and seed

weight/plant than and it was at par with 50 % RDN through CF + 50 % RDN through VC and 50 % RDN through CF + 50 % RDN through FYM during both the years. (Table 1). Among integrated sources significantly highest number of pods/plant, number of seeds/plant, seed weight/plant of soybean was found in treatment 50 % RDN through CF + 50 % RDN through VC followed 50 % RDN through CF + 50 % RDN through FYM than rest of treatments. The least values were observed with the 25 % RDN through CF + 25 % RDN through VC + 25 % RDN through FYM + 25 % RDN through NC during both the years. This was mainly due to combined application of organic manures improved soil physical, chemical and biological environment of soil for favorable crop growth and yield also provide all essential plant nutrients including micronutrients to accelerate the respiratory process that increase cell permeability which encourage proliferous root system resulting better absorption of water and nutrients from lower layers thus resulting in higher yield attributes. FYM, VC and neem cake alone was not able to adequately supply of plant nutrients specially phosphorus (Patra and Sinha, 2014). These results are in corroborated with those reported by Kathiresa *et al*. (1999), Pattanashetti *et al*. (2002), Thanunathan *et al*. (2002) and Ghosh *et al*. (2005).

Seed yield (28.23 q/ha) and straw yield (33.49 q/ha) recorded significantly higher with application of 100 % RDF through CF than rest of treatments. Among integrated sources 50 % RDN through CF + 50 % RDN through VC (27.79 q/ha) and straw yield (33.14 q/ha). It was closely followed by application of 50 % RDN through CF + 50 % RDN through FYM (27.00 q/ha) and straw yield (32.86 q/ha). As there was ideal condition for soil microflora due to application of VC and FYM along with CF increased availability of nutrients, there was improvement in both growth and yield attributes, which in turn might have increased the yield of soybean. This combination play key role in enhancing the efficiency of utilization of native as well as applied nutrients and augment the availability of certain micronutrients and improved the activities of soil microorganisms involved in nutrient transformation and fixation which leading to higher seed yield and yield components. Similar results were postulated by Rana and Badiyala (2014), Singh *et al*. (2014), Maheswari and Sivasakthivelan (2015) and Singh *et al*. (2015). (Table 1).

Residual effect on onion (for seed)

Growth attributes (plant height, number of flower stalk per bulb, height of flower stalk, diameter of flower stalk, diameter of umbel), yield attributes (seed weight/bulb and 1000 seed weight and seed yield was significantly influenced due to residual effect of nutrients applied to the preceding soybean during both the years and number of flower of onion (for seed) with the application of 100 % RDF to previous season soybean than different nutrient treatments during both the years however, it was at par with treatment 50 % RDN through CF + 50 % RDN through VC and 50 % RDN through CF + 50 % RDN through FYM (Table 2). Among the integrated treatments 50 % RDN through CF + 50 % RDN through VC and 50 % RDN through CF + 50 % RDN through FYM show residual effect due to slow and gradual release of nutrients and preceding soybean is a legume crop having considerable potential to fix atmospheric nitrogen that can be utilized for succeeding post rainy season crop thus might have improved the performance of onion (for seed). Similar results are in accordance with Shrawan Singh *et al*. (2004), Reddy and Reddy (2005), Pawar *et al*. (2009), and Verma *et al*. (2011). Among the fertilizer levels to *rabi* onion (for seed), application of 125 % RDN through CF (5.05, 5.45 and 5.25 q ha^{-1}) was recorded significantly higher seed yield over 75 % RDN through CF and at par with 100 % RDN through CF (4.96, 5.35 and 5.16 q ha^{-1}) during both the years and pooled respectively. Might be due to added higher amount and readily supply of nutrients helped the increase in the availability of major nutrients and thereby leading to higher yield attributes of onion (for seed) reflecting higher seed yield. The present results are in conformity with those of Similar result reported by, Patil *et al*. (2007), Adagale *et al*. (2009), Khang *et al*. (2011), Jawadagi (2012) and Singh *et al*. (2014).

Quality

Nutrient management had significant influence on protein content, oil content, oil yield and oil quality reported by Hemantaranjan *et al*. (2000) (Table 2). Application of 100 % RDF through CF was found higher oil and protein content. Also least oil content was found with the application of 25 % RDN through CF + 25 % RDN through VC + 25% RDN through FYM + 25 % RDN through NC during both the years, respectively. As N is a basic constituent of protein and with increase in rates of N application 100 % RDF, the N availability increased which resulted is increased protein content in seeds. The increase in oil and protein might may be due to increased availability and higher uptake of N might have increased the amino acid synthesis and thereby could have improved the seed oil and protein via their translocation to the seed. Rana and Badiyala (2014) revealed that use of FYM + VC recorded highest oil yield of soybean as compared to rest of the organic combinations. Since, the oil yield is mainly the function of seed yield and their respective oil content in the seed, oil yield increased with the increase in the fertility levels and successive addition of supplementary ingredients viz., FYM and VC. (Table 3).

Nutrient uptake and soil fertility

The maximum nutrient uptake of the soybean-onion (for seed) cropping system observed in 100 % RDF over 50 % RDN through CF + 50 % RDN through VC and 50 % RDN through CF + 50 % RDN through FYM at harvest during both the years. Among integrated sources application of 50 % RDN through CF + 50 % RDN through VC higher uptake over 50 % RDN through CF + 50 % RDN through FYM at harvest during both the years (Table 3,4). The better response to 50 % RDN through CF + 50 % RDN through VC and FYM may be ascribed on the higher nutrient content and lower C: N ratio leading to increased nutrient uptake by cropping system. This might be due to increased supply of nutrient sources to the crop, as well as due to the indirect effect resulting from reduced loss of nutrients from organic sources. It was probably due to the fact that application of FYM increased apparent availability of native and added. Similar findings were also reported by Ramesh *et al*. (2009) indicated that soil organic carbon, available N, P, K status and biological activity of soil in terms of dehydrogenase enzyme were significantly improved in integrated treatment compared to chemical fertilizers when studied under soybean-onion (for seed) cropping system.

The significantly highest soil available N, P and K were recorded in 100 % RDF over 50 % RDN through CF + 50 % RDN through VC and 50 % RDN through CF + 50 % RDN through FYM during both the years (Table 4).

The data on net gain and loss of nutrients after completion of second cycle of soybean-onion (for seed) system are

presented in Table 4.

The application of different nutrient sources to soybean showed a negative balance of nitrogen and potassium in soil and as far as phosphorus balance is concerned showed positive balance as compare to its initial value. The actual nitrogen balance in soybean-onion (for seed) cropping system showed maximum negative nitrogen balance in treatments treated with 100 % RDF followed by 50 % RDN through CF + 50 % RDN through VC. As regarding the potassium negative balance was maximum under 100 % RDF followed by 50 % RDN through CF + 50 % RDN through VC. Phosphorus showed positive balance as compare to its initial value maximum phosphorus built up recording 25 % RDN through CF+ 25 % RDN through FYM + 25 % RDN through VC + 25 % RDN through NC followed by application of application of 50 % RDN through CF + 50 % RDN through VC while minimum in CF + 50 % RDN through NC. Higher amount of residual N, P and K analyzed might be attributed to the increased activity of micro-organisms and nodulation leading to greater mineralization of applied and inherent nutrients. This increase might be due to increased organic matter content in the soil and higher availability of nutrients to the crop (Patil and Varade, 1998). Addition of FYM increased the activity of micro-organisms when compared with fertilizers alone. However, microbial population was lower in fertilized plot with 100% RDF. Application of FYM and VC in combination with RDF were found to be most promising in enhancing actinomycetes and bacterial population in soil. (Table 3).

In treatment receiving 25 % RDN through CF+ 25 % RDN through FYM + 25 % RDN through VC +25 % RDN through NC recorded high build up of P nutrients which might be due to more availability of nutrients from sources, whereas, highest negative balance of N was in 100 % RDF through CF due to continuous removal of nutrients by both the crops. The negative balance of nitrogen might be due to fixation of atmospheric nitrogen by the soybean, onion (for seed) fulfilling the excess nitrogen requirement. It also indicate that there is need to apply the nitrogen to exploit the full potential yield of soybean-onion (for seed) crop sequence. (Table 5).

Table 1: Effect of nutrient-management practices on growth, yield attributes and yield of soybean (mean data of 2 years)

Treatment	Plant height (cm)		Number of pods plant^{-1}		Number of seeds pod^{-1}		Seed weight plant^{-1} (g)		100 seed weight (g)		Seed yield (q ha^{-1})			Straw yield (q ha^{-1})		
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	Pooled	2014	2015	Pooled
T_1 : 100 % RDF	51.19	53.82	45.88	52.50	2.74	2.83	13.12	14.73	16.21	17.35	27.60	28.86	28.23	33.22	33.75	33.49
T_2 : 50 % RDN through CF + 50 % RDN through FYM	50.08	52.72	44.95	51.46	2.58	2.67	12.52	14.12	15.60	16.53	26.27	27.73	27.00	32.14	33.59	32.86
T_3 : 50 % RDN through CF + 50 % RDN through VC	50.61	53.31	45.53	52.21	2.69	2.76	12.84	14.53	15.98	16.68	26.84	28.73	27.79	32.55	33.73	33.14
T_4 : 50 % RDN through CF + 50 % RDN through NC	44.75	46.97	40.74	48.39	2.49	2.58	11.98	13.30	15.19	15.63	25.18	27.07	26.12	30.46	33.02	31.74
T_5 : 25 % RDN through CF+ 25 % RDN through FYM + 25 % RDN through VC + 25 % RDN through NC	43.25	44.62	38.16	46.70	2.36	2.47	11.45	12.49	14.45	15.02	23.41	25.30	24.35	29.32	31.03	30.18
SEm ±	1.10	1.01	1.13	1.20	0.06	0.06	0.23	0.33	0.28	0.38	0.46	0.48	0.47	0.42	0.40	0.41
CD at 5 %	3.18	2.93	3.27	3.46	0.16	0.17	0.67	0.96	0.80	1.09	1.35	1.38	1.34	1.20	1.17	1.16

Table 2: Effect of nutrient-management practices on growth, yield attributes and seed yield of onion (mean data of 2 years)

Treatment	Plant height (cm)		Number of flower stalk bulb^{-1}		Height of flower stalk (cm)		Diameter of flower stalk (cm)		Diameter of umbel (cm)		Seed weight bulb^{-1} (g)		1000 seed weight (g)		Seed yield (q ha^{-1})		
	2014	2015	2014	2015	2014	2015	2014	2015	2014	201s5	2014	2015	2014	2015	2014	2015	Pooled
T : Nutrient management to kharif soybean																	
T_1 : 100 % RDF	79.35	81.12	6.43	6.62	72.00	73.92	1.49	1.53	8.15	8.49	13.90	15.82	3.98	4.21	5.70	6.13	5.92
T_2 : 50 % RDN through CF + 50 % RDN through FYM	76.35	80.00	5.98	6.19	68.71	71.19	1.42	1.48	7.80	8.19	12.74	14.77	3.78	3.92	5.22	5.62	5.42
T_3 : 50 % RDN through CF + 50 % RDN through VC	77.55	80.35	6.29	6.48	69.77	72.15	1.44	1.51	8.01	8.35	13.34	15.51	3.91	4.12	5.41	5.96	5.68
T_4 : 50 % RDN through CF + 50 % RDN through NC	73.49	76.00	5.94	6.01	65.70	68.08	1.40	1.46	7.20	7.54	10.82	12.25	3.46	3.82	4.16	4.39	4.28
T_5 : 25 % RDN through CF+ 25 % RDN through FYM + 25 % RDN through VC + 25 % RDN through NC	71.32	75.45	5.58	5.67	64.48	66.71	1.37	1.43	6.66	6.94	10.15	11.88	3.33	3.72	3.13	3.38	3.25
SEm ±	1.04	1.09	0.15	0.069	1.19	1.09	0.02	0.01	0.13	0.25	0.40	0.38	0.06	0.09	0.17	0.18	0.21
CD at 5 %	79.35	3.57	0.51	0.226	3.90	3.56	0.06	0.05	0.42	0.83	1.30	1.24	0.20	0.30	0.55	0.59	0.64
F: Fertilizer levels to rabi onion (for seed)																	
F_1: 75 % RDN through CF	75.08	77.79	5.63	5.69	65.69	67.79	1.33	1.42	6.71	7.05	11.23	13.36	3.55	3.88	4.16	4.49	4.32
F_2: 100 % RDN through CF	75.84	78.71	6.19	6.35	69.01	71.38	1.45	1.50	7.95	8.29	12.57	14.32	3.74	3.94	4.96	5.35	5.16
F_30: 125 % RDN through CF	75.91	79.25	6.32	6.55	69.70	72.06	1.49	1.52	8.04	8.36	12.78	14.46	3.78	4.05	5.05	5.45	5.25
SEm ±	0.23	0.21	0.04	0.07	0.26	0.24	0.01	0.005	0.04	0.05	0.08	0.07	0.02	0.04	0.04	0.05	0.06
CD at 5 %	0.70	0.61	0.14	0.22	0.78	0.71	0.03	0.014	0.13	0.16	0.25	0.21	0.06	0.11	0.14	0.15	0.17
Interaction (T×F)	NS	NS	Sig.	Sig.	Sig.	Sig.	NS	NS	Sig.	Sig.	Sig.	Sig.	NS	NS	Sig.	Sig.	NS

Table 3: Effect of nutrient-management practices on oil and protein content and fungi, bacteria and actinomycetes count in soybean (2014 and 2015)

Treatment		Oil content (%)		Protein content (%)		Fungi (CFU x 10^{-4} g^{-1} soil)		Bacteria (CFU x $10^{-8}g^{-1}$ soil)		Actinomycetes (CFU x 10^{-5} g^{-1} soil)	
		2014	2015	2014	2015	2014	2014	2015	2014		
T_1 :	100 % RDF	19.31	19.56	39.64	39.84	19.07	20.42	24.64	26.38	15.82	17.33
T_2 :	50 % RDN through CF + 50 % RDN through FYM	18.67	19.08	38.89	39.65	29.31	30.48	34.40	36.85	26.09	27.47
T_3 :	50 % RDN through CF + 50 % RDN through VC	19.06	19.34	39.37	39.67	29.55	30.90	34.45	37.08	26.30	27.81
T_4 :	50 % RDN through CF + 50 % RDN through NC	18.13	18.64	38.78	39.43	21.82	23.16	27.39	29.12	18.57	20.08
T_5 :	25 % RDN through CF + 25 % RDN through FYM + 25 % RDN through VC + 25 % RDN through NC	17.44	17.85	38.65	39.19	24.94	25.97	30.67	32.41	21.51	22.91
	SEm ±	0.06	0.05	0.14	0.10	0.11	0.23	0.25	0.15	0.13	0.22
	CD at 5 %	NS	NS	NS	NS	0.32	0.68	0.73	0.45	0.39	0.65

Table 4: Total nutrient and micronutrient uptake by soybean as influenced by different treatments of soybean (2014 and 2015)

Treatment		Nitrogen (kg ha^{-1})		Phosphorus (kg ha^{-1})		Potassium (kg ha^{-1})		Fe		Mn		Zn		Cu	
		2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T_1 :	100 % RDF	191.00	198.48	19.44	20.54	82.34	87.01	135.33	137.85	145.09	146.46	41.88	44.41	5.92	8.07
T_2 :	50 % RDN through CF + 50 % RDN through FYM	178.29	182.86	16.77	17.56	75.03	81.46	137.72	141.14	148.88	150.75	45.85	46.83	6.36	8.36
T_3 :	50 % RDN through CF + 50 % RDN through VC	183.68	194.41	18.01	19.24	78.50	84.68	139.60	142.11	150.64	152.51	46.32	48.38	6.48	8.75
T_4 :	50 % RDN through CF + 50 % RDN through NC	168.02	173.07	15.01	16.16	69.43	77.74	136.73	139.75	147.35	148.61	43.93	46.46	6.20	8.26
T_5 :	25 % RDN through CF + 25 % RDN through FYM + 25 % RDN through VC + 25 % RDN through NC	153.17	157.43	12.61	13.97	62.64	70.53	140.04	140.70	148.88	149.75	44.24	46.77	6.31	8.34
	SEm ±	3.00	3.28	0.31	0.31	1.07	1.16	5.40	5.90	5.40	5.90	3.30	3.49	0.47	0.54
	CD at 5 %	8.64	9.45	0.91	0.90	3.10	3.35	NS	NS	NS	NS	NS	NS	NS	NS

Table 5: Nutrient balance sheet as influenced by different treatments after harvest of soybean-onion (for seed) crop sequence (2014-15)

Treatment	Initial nutrients (kg ha^{-1})			Nutrients applied to crop (kg ha^{-1})			Nutrients uptake by crops (kg ha^{-1})			Soil available nutrients after harvest (kg ha^{-1})			Nutrients Balance (kg ha^{-1})		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
T_1 F_1 :75% RDN	226.00	18.00	358.00	125.00	55.00	42.00	209.14	25.12	92.25	222.23	19.12	357.08	-80.37	28.77	-49.33
T_1 F_2 100% RDN	226.00	18.00	358.00	150.00	55.00	42.00	211.36	25.83	93.06	227.53	20.83	364.83	-62.89	26.34	-57.89
T_1N_3 : 125 % RDN	226.00	18.00	358.00	175.00	55.00	42.00	212.10	26.16	93.39	234.73	21.54	371.44	-45.83	25.31	-64.83
T_2F_1 : 75 % RDN	226.00	18.00	358.00	125.00	44.32	64.70	194.02	21.12	83.79	214.22	15.09	348.31	-57.23	26.11	-9.41
T_2F_2 : 100 % RDN	226.00	18.00	358.00	150.00	44.32	64.70	196.00	21.79	84.53	215.08	15.91	348.77	-35.09	24.62	-10.60
T_2N_3 : 125 % RDN	226.00	18.00	358.00	175.00	44.32	64.70	196.44	22.05	84.74	221.32	16.85	350.98	-16.76	23.43	-13.02
T_3F_1 : 75 % RDN	226.00	18.00	358.00	125.00	48.64	61.30	200.59	23.05	87.92	221.21	16.06	352.91	-70.80	27.53	-21.53
T_3F_2 : 100 % RDN	226.00	18.00	358.00	150.00	48.64	61.30	202.58	23.67	88.58	224.13	17.38	357.42	-50.71	25.58	-26.70
T_3F_3 : 125 % RDN	226.00	18.00	358.00	175.00	48.64	61.30	203.07	23.86	88.79	229.69	18.94	368.02	-31.77	23.84	-37.51
T_4F_1 : 75 % RDN	226.00	18.00	358.00	125.00	40.94	48.38	178.95	17.84	76.42	208.35	13.55	334.44	-36.31	27.55	-4.48
T_4F_2 : 100 % RDN	226.00	18.00	358.00	150.00	40.94	48.38	182.85	18.84	77.56	212.03	15.48	340.71	-18.89	24.61	-11.89
T_4F_3 : 125 % RDN	226.00	18.00	358.00	175.00	40.94	48.38	183.12	19.06	77.71	216.42	16.36	344.01	1.46	23.52	-15.34
T_5F_1 : 75 % RDN	226.00	18.00	358.00	125.00	38.57	66.16	162.10	14.74	68.65	193.58	12.86	328.67	-4.68	28.96	26.84
T_5F_2 : 100 % RDN	226.00	18.00	358.00	150.00	38.57	66.16	164.03	15.25	69.34	203.94	13.35	332.82	8.03	27.97	22.00
T_5F_3 : 125 % RDN	226.00	18.00	358.00	175.00	38.57	66.16	164.77	15.41	69.54	209.94	14.58	332.47	26.29	26.58	22.15
General mean	226.00	18.00	358.00	150.00	45.49	56.51	190.74	20.92	82.42	216.96	16.53	348.86	-31.70	26.05	-16.77

Table 6: Nutrient balance sheet as influenced by different treatments after harvest of soybean-onion (for seed) crop sequence (2015-16)

Treatment	Initial nutrients (kg ha^{-1})			Nutrients applied to crop (kg ha^{-1})			Nutrients uptake by crops (kg ha^{-1})			Soil available nutrients after harvest (kg ha^{-1})			Nutrients Balance (kg ha^{-1})		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
T_1F_1 : 75 % RDN	222.23	19.12	357.08	125	55	42	217.77	26.65	97.45	232.05	20.55	360.19	- 02.59	26.91	-58.56
T_1F_2 : 100 % RDN	227.53	20.83	364.83	150	55	42	220.71	27.76	98.53	235.45	22.26	367.93	-78.63	25.81	-59.63
T_1N_3 : 125 % RDN	234.73	21.54	371.44	175	55	42	221.41	28.05	98.78	239.66	23.30	373.38	-51.33	25.19	-58.72
T_2F_1 : 75 % RDN	214.22	15.09	348.31	125	52.78	64.96	199.88	22.55	90.87	221.86	16.52	351.42	-82.52	28.80	-29.02
T_2F_2 : 100 % RDN	215.08	15.91	348.77	150	52.78	64.96	202.00	23.25	91.85	231.28	17.34	354.60	-68.19	28.10	-32.71
T_2N_3 : 125 % RDN	221.32	16.85	350.98	175	52.78	64.96	202.65	23.52	92.20	225.10	18.28	351.88	-31.43	27.83	-28.14
T_3F_1 : 75 % RDN	221.21	16.06	352.91	125	56.91	61.3	212.36	24.70	94.62	217.95	17.49	356.02	-84.10	30.79	-36.42
T_3F_2 : 100 % RDN	224.13	17.38	357.42	150	56.91	61.3	215.26	25.70	95.59	237.64	18.81	360.53	-78.76	29.79	-37.40
T_3F_3 : 125 % RDN	229.69	18.94	368.02	175	56.91	61.3	216.15	26.08	96.10	248.11	20.37	371.13	-59.57	29.40	-37.91
T_4F_1 : 75 % RDN	208.35	13.55	334.44	125	44.26	48.73	185.00	19.37	85.10	215.56	14.98	337.55	-67.22	23.46	-39.48
T_4F_2 : 100 % RDN	212.03	15.48	340.71	150	44.26	48.73	188.55	20.31	86.32	217.49	16.91	343.81	-44.01	22.52	-40.69
T_4F_3 : 125 % RDN	216.42	16.36	344.01	175	44.26	48.73	189.03	20.55	86.52	223.48	17.79	347.12	-21.09	22.28	-40.90
T_5F_1 : 75 % RDN	193.58	12.86	328.67	125	49.47	66.53	167.63	16.49	76.99	200.26	14.29	331.78	-49.30	31.55	-13.57
T_5F_2 : 100 % RDN	203.94	13.35	332.82	150	49.47	66.53	169.08	16.92	77.58	211.88	14.78	335.93	-27.02	31.12	-14.16
T_5F_3 : 125 % RDN	209.94	14.58	332.47	175	49.47	66.53	169.46	17.09	77.77	219.03	16.01	335.58	-3.55	30.96	-14.35
General mean	216.96	16.53	348.86	150.00	51.68	56.70	198.46	22.60	89.75	225.12	17.98	351.92	-56.62	27.63	-36.11

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