Original Research Article

Effect of fertigation of watersoluble fertilizers on growth, yield of cowpea and nutrientsavailabilityin soil under rice-cowpea cropping sequence

ABSTRACT

A investigation was carried out to study the Growth and yield of cowpea and primary nutrients availability in soil as influenced by fertigation of water-soluble fertilizers under rice-cowpea cropping sequence.Hybrid rice was tested under aerobic condition during*Kharif*2015-16 and 2016-17 with 16 treatments replicated thrice in randomized block design. The results indicated that, the treatment, 100% RDF through water soluble fertilizer at 8 DI was recorded significantly higher growth and yield determinants, higher seed yield (12.94 q ha^{-1})and haulm yield (26.17 q ha^{-1}) of cowpea. Significant higher organic carbon(0.57 %) was recorded with the application 100% STCR dose with WSF through fertigation at 8 DI and higher available N(146.38 kg N ha^{-1}), P_2O_5(122.67 kg $P_2O_5ha^{-1}$)and K_2O (130.17 kg K_2Oha^{-1})content in soil recorded 100% water soluble fertilizers (WSF) applied at4 DI. However, exchangeable calcium[3.51 cmol (p^+) kg^{-1}], magnesium [2.55 cmol (p^+) kg^{-1}], available sulphur[12.50 ppm] in soil were recorded with 100% conventional fertilizers applied plots through PoP.Significantly higher DTPA extractable Fe (18.45 mg kg^{-1}) noticed with 100% STCR of WSF at 8 DI. However, significantly higher DTPA extractable Zn (1.44 mg kg^{-1}) and Cu (0.57 mg kg^{-1}) was recorded with the application of 100% RDF with WSF at 4 DI. Significantly higher DTPA extractable Mn (22.78 mg kg^{-1}) noticed with 100% STCR of WSF at 4 DI.

Key words: Fertigation, sol test crop response, water soluble fertilizer, conventional fertilizer, cowpea, soil properties

INTRODUCTION

"Cowpea (*Vigna unguiculata*) is most widely grown pulse-cum-vegetable crop. It contains 24.6 per cent protein and also plays an important role in maintaining the soil fertility by fixing the atmospheric nitrogen. Cowpea meets 80% of its nitrogen (N) requirement from symbiotic nitrogen fixation and can fix up to 130 kg N ha^{-1} from atmosphere. It leaves substantial amount of residual nitrogen for subsequent crops and adds plenty of organic matter to maintain and improve soil health and fertility.They are mainly grown in the warm climates since they require warm soil temperatures between 27□ and 35□ for good establishment (Dugje*et al.*, 2009). They are adapted to a wide variety of soils from heavy to light textured and from the humid tropics to the semi-arid tropics" (Faloye and Alatise, 2015). "Surface flooding method of irrigation, commonly practiced by thefarmers and is expensive since it causes high water loss. Drip or sprinklerirrigations was proven efficient over surface irrigation methodof irrigation. For efficient irrigationmanagement in the field, water lost from plant and soil play an important role byproviding information for accurately determination of crop-water requirements and irrigation schedule" (Dasila*et al.*, 2016). "Moisturestress also markedly retards root hair and nodule growth and nitrogen fixation" (Onuh and Donald, 2009). "The most sensitive growth stages of cowpea to drought were flowering and pod filling, with yield reduction from 35 to 69 % depending on the timing and length of the drought treatment.A soil water deficit during the vegetative stage had the least effect on crop yield. This, coupled with decreased evaporation, resulted in a water-use efficiency which was greater than that of control treatment. The water-use efficiencies of the other stage deficit treatments were decreased below that of the control because of large decrease in crop yield" (Aboamera, 2010). Further, "Rice-cowpea cropping system is one of the important and economically remunerative system practiced in India. But, cowpea is hardy crops come up well with low fertility soil or residual nutrients applied for the previous crops due symbiotic association with rhizobium microorganisms survive in their roots, they can fix the atmospheric N to plant available form. Considering the effective management of water as scarce resources, there is a need to determine water use of crop from planting to harvest. Scheduling the required irrigation water for each crop will help in minimizing the water lost through the growing season. The effect of water deficit on cowpea growth and yield depends upon the degree of stress and the development stage at which the stress occurs" (Hsiao and Acevedo, 1974). Based on the above discussion the present study was initiated by integrated use of organic fertilizers along with inorganic fertilizers either through water soluble fertilizer or conventional fertilizer were applied through different approaches for aerobic rice and their residual performance on succeeding cowpea especially the aspects of on growth, yield of cowpea crop and nutrient availability in soil after harvest of residualcowpea crop.

MATERIAL AND METHODS

The experiment was conducted with sixteen treatments replicated thrice during *Kharif* 2015 and 2016 with hybrid rice (KRH-4) as the test crop and their residual effect on cowpea crop

(KM-5) which was grown during summer seasons of 2016 and 2017 at ZARS, GKVK, Bangalore. Two years pooled data of aerobic rice crop was collected and analyzed in RCBD design. "Treatments comprised of T_1:Control (without NPK fertilizers), T_2:100% RDF-Conventional fertilizers through soil application as per PoP, T_3:100% RDF-Conventional fertilizers through fertigation at 4 days interval (DI), T_4:100% RDF-Conventional fertilizers through fertigation at 8 days interval, T_5:100% RDF-Water soluble fertilizers through fertigation at 4 days interval, T_6:50% RDF-Water soluble fertilizers through fertigation at 4 days interval, T_7:30% RDF-Water soluble fertilizers through fertigation at 4 days interval, T_8:100% RDF-Water soluble fertilizers through fertigation at 8 days interval, T_9:50% RDF-Water soluble fertilizers through fertigation at 8 days interval, T_{10}:30% RDF-Water soluble fertilizers through fertigation at 8 days interval, T_{11}:100% STCR-Water soluble fertilizers through fertigation at 4 days interval, T_{12}:50% STCR-Water soluble fertilizers through fertigation at 4 days interval, T_{13}:30% STCR-Water soluble fertilizers through fertigation at 4 days interval, T_{14}:100% STCR-Water soluble fertilizers through fertigation at 8 days intervals, T_{15}:50% STCR-Water soluble fertilizers through fertigation at 8 days intervals and T_{16}:30% STCR-Water soluble fertilizers through fertigation at 8 days intervals" (Jayanthi et al., 2023).

For hybrid rice, as per the package of practice the recommended dose of farm yard manure @ 10 t ha^{-1} was incorporated into the soil 20 days before sowing, $ZnSO_4$ @ 20 kg ha^{-1} and N, P_2O_5, K_2O @ 125:62.5:62.5 kg ha^{-1}, respectively were applied as per the treatments except for the absolute control treatment. For treatment T_2, where N was applied in three split doses *viz.*, 50% as basal, the remaining 50% nitrogen was top dressed in two equal splits during active tillering and before panicle initiation stage, 100% P nutrient was applied at the time of sowing and K was applied in two equal splits as basal and at active tillering stage through conventional fertilizers *viz.*, urea, single super phosphate and muriate of potash, respectively. Basal dose of fertilizers were applied at the time of sowing @ 30%, 50% and 30% (N, P_2O_5 andK_2O, respectively)from T_3 to T_{16} treatments. For T_3 and T_4 treatments, in which the remaining 70%, 50% and 70% of N, P_2O_5 andK_2O, respectively were supplied through conventional fertilizers at 4 (15 times) and 8 (8 times) days interval of fertigation. Further, for the water soluble fertilizers treatments (*viz.*,T_5,T_6,T_7,T_{11},T_{12} & T_{13} and T_8,T_9,T_{10},T_{14},T_{15}& T_{16})theremaining 70%, 50% and 70% of N, P_2O_5 and K_2O, respectively were done through different grades of water soluble fertilizers *viz.*, 19:19:19 (19 all), Mono Potassium Phosphate

(MPP), Mono ammonium phosphate (MAP), Sulphate of Potash (SOP) and Calcium nitrate (CN) at 4 (15 times) and 8 (8 times) days interval of fertigation.The fertigation was done through ventury system starting from 20 days after sowing and continued up to 80 days after sowing or panicle initiation stage to each plot as per the treatments. Irrigation schedule was common for all the treatments. In both the years, after the harvest of the aerobic rice, land preparation was carried out, in summer season and cowpea was taken as a succeeding crop to check the residual effect of fertigation of water soluble fertilizers.

The initial soil samples were collected from each plot separately before conducting the experiment and soil samples were air dried, powdered, sieved, and stored in plastic cover. And analysis was carried out for different physical and chemical properties as per standard procedures. Similarly, after the harvest of the aerobic rice and cowpea, the soil samples were collected in each plot for each crop from both the years and analysis was done as per the standard procedures. The initial experimental field soil is sandy clay loam in texture and neutral in soil reaction (6.72). The initial fertility status of soil showed low OC (0.48%) content. And the soil was low in available N content, medium in available P_2O_5 and K_2O (212.59, 21.98 and 210.43 kg ha^{-1}, respectively) and sufficient amount of exch. Ca and Mg (3.96 and 2.63 [cmol (p^{+}) kg^{-1}], respectively) and available S (17.60 ppm) content in present in soil. DTPA extractable micronutrients *viz.*, (Fe-18.28, Zn-1.65, Mn-23.91and Cu-0.61mg kg^{-1}) content in the soil was above critical levels.

After the harvest of previous hybrid rice crop under aerobic condition, the plots were tilled individually and stubbles were removed to bring the soil to fine tilth. Leveling within each plot was done to facilitate uniform drip irrigation.Cowpea (*var.*KM-5) was used for experimentation during summer season to study the residual effect of different doses and forms of fertilizers along with FYM after the harvest of the hybrid rice crop at *kharif*. The cowpea seeds were treated with Rhizobium and PSB as per the package of practice (PoP). The furrows were opened at 45cm and seeds were placed at 10cm distance within the rows at a depth of 5cm with a seed rate of 25 kg ha^{-1} and covered with soil (Table1).

Table 1: Treatments imposed for succeeding cowpea crop.

Crop	Cowpea
Variety	KM-5
Spacing	45 cm x 10 cm

Design	RCBD
Season	Summer 2016 and 2017
Plot size	4.50 m x 4.20 m=18.9 m^2 (gross plot size) 4.00 m x 3.80 m=15.2 m^2 (net plot size)
No of Treatments	16
No of replications	3
NPK fertilizers	No fertilizers and manures were applied for residual cowpea crop

RESULTS AND DISCUSSION

Growth parameters of cowpea

Treatment which received 100% RDF through water soluble fertilizer at 8 DI (T_8) was recorded significantly higher plant height (58.47 cm), number of branches plant^{-1} (11.71) and total dry matter accumulation plant^{-1} (70.60 g) compared to soil application of conventional fertilizes and control treatments (Table2).This improvement in growth parameters of cowpea crop is associated with the increase in available nitrogen, phosphorus and potassium in soil which were sufficient and balanced dose for greater meristematic activity which have promoted better interception of light, greater canopy development, absorption and utilization of radiant energy with greater CO_2 fixation, leading to enhanced photosynthetic efficiency resulting in increased leaf area and dry matter production as observed by Abayomi *et al*. (2008). Similar results were recorded by Lingaraju*et al*. (2018) in residual cowpea crop through SSNM and STCR approaches.

Yield and yieldparameters of cowpea

Significantly higher number of pods plant^{-1} of cowpea(16.67 cm), pod length (16.58), number of seeds pod^{-1} in cowpea (16.10) and test weight (11.93 g) were recorded in treatment, which received 100% RDF through water soluble fertilizers at 8 DI (T_8) compared to all other treatments soil application of conventional treatment and control treatment. Similarly, the same treatment (T_8) has recorded significantly higher seed yield (12.94 q ha^{-1}) and haulm yield (26.17 q ha^{-1}) in absolute control treatment (T_1) without NPK and FYM application (Table 3.)

Soil chemical properties

pH

The pH of the soil after the harvest of the succeeding cowpea crop did not showed any significant difference between the treatments. However, the pH values ranged from 6.82-7.00 in post-harvest soils after residual cowpea crop. Similar results were observed by other authors (Santhi and Selvakumari (1999); Punitha (2016) and Shruthi (2017)) who reported that residual effect of varying quantities of inorganic fertilizers in combination with organics did not alter the soil pH appreciably after the harvest of residual crop (Table 4).

Electrical conductivity

Electrical conductivity did not differ significantly (Table 4) due to residual effect of inorganic and organic manures on succeeding cowpea. However, marginal increase in EC was observed in plots which received higher level of NPK fertilizers with organic manures. Whereas, slightly lesser EC was observed in treatments without any fertilizers and organic manures reported by Shruthi (2017).

Organic carbon

The treatment, 100% STCR dose with WSF through fertigation at 8 DI (T_{14}) has recorded significantly higher organic carbon (OC) content of 0.57% in soil than other treatments except T_5, T_{11} and T_{14}, which were statistically on par (Table 4). However, significantly lower OC content (0.44%) in soil was recorded in control (T_1). This might be attributed to the addition of compost and FYM and inorganic fertilizers which have enhanced the soil organic-C due to mineralization as well as the more residues left over from the main crop with higher dose of fertilizers treated plot as documented by Bandole.Montemurro *et al.* (2006) reported the increase in soil organic carbon status with the application of urban compost.

Primary nutrients

Significantly higher available nitrogen (N) content (146.38 kg N ha^{-1}), available phosphorus (P_2O_5) content (122.67 kg P_2O_5 ha^{-1}) and available potassium (K_2O) content (130.17 kg K_2O ha^{-1}) in soil were recorded in 100% water soluble fertilizers (WSF) applied at 4 DI through STCR approach (T_{11}) than other treatments.This may be due to more residual accumulation of N from previous crop as per the STCR equation might have resulted in more available N status in soil compared to conventional treatments where more loss of N from the soil in various ways resulted in lesser availability of N in conventional fertilizer treatments and to a greater multiplication of soil microbesas a result of which organically bound nitrogen was converted to inorganic form of nitrogen along with N from FYM decomposition and some little quantity from native N from soil (Bharadwaj and Omanwar,1994). Most of the applied P may be turned to non-soluble form in a short time after its application and the observed concentrations build up in the upper soil layer could affect root growth and create unfavourable conditions for P uptake. Soil application of higher dose of potassic fertilizers through fertigation of WSF as per the STCR equation which may be attributed for higher available K content in soil. However, in conventional fertilizer treatments may be due to unavailability of K from soil due to movement of K into deeper layer along with water and accumulate in deeper layer or converted into nonexchangeable form in the upper soil layer, which was corroborated with the finding of Milap *et al*. (2004).

Secondary nutrients

Significantly higher exchangeable calcium (Ca) content [3.51 cmol (p^+) kg^{-1}], exchangeable magnesium (Mg) content of 2.55 cmol (p^+) kg^{-1} and available sulphur (S) content in soil (12.50 mg kg^{-1}) in soil was recorded in 100% conventional fertilizers applied plots through PoP (T_2) than control (T_1) treatment.Soil application and fertigation with 100% RDF through conventional fertilizers treated plots have registered higher availability of secondary nutrients in soil. This may be due to lesser uptake of secondary nutrients by aerobic rice in conventional fertilizer treatments might have resulted in lesser biomass yield which leads to higher residual secondary nutrients content in soil (Table 5). Present study results are in accordance with Chandrakanth (2015) in maize crop who reported that addition of FYM along with SSP have enhanced the available S content in soil and also similar findings were observed in maize (Santhosha, 2013) and in cabbage (Sundaresh, 2019).

Micronutrients

Significantly higher DTPA extractable iron (Fe) content (18.45 mg kg^{-1}) in soil was noticed in 100% STCR with WSF at 8 DI (T_{14}) than other treatments except T_5, T_6, T_8, T_9, T_{11}, T_{12}, T_{13} and T_{15}, which were statistically on par. 100% RDF with WSF at 8 DI (T_8) has recorded significantly higher DTPA extractable zinc (Zn) content (1.44 mg kg^{-1}) in soil compared to T_1, T_7, T_9, T_{10}, T_{13} and T_{16} and remainingwere statistically on par.

Significantly higher DTPA extractable manganese (Mn) content in soil (22.78 mg kg^{-1}) was recorded in 100% STCR with WSF at 4 DI (T_{11}) compared to T_1, T_2, T_3, T_4, T_6, T_7, T_9, T_{10}, T_{12}, T_{13}, T_{15} and $T_{16}$and remaining all other treatments were statistically on par.Fertigation with 100% RDF through WSF at 8 DI (T_8) treatment has recorded significantly higher Cu content in the soil (0.57 mg kg^{-1}) than other treatments *viz.*, T_1, T_6, T_7 and T_{10} and remaining all other treatments were statistically on par. However, control treatment has recorded significantly lower DTPA extractable copper content of 0.40 mg kg^{-1} in soil(Table 6).

This increase in micronutrients content in soil may be due to FYM being an additional source of micronutrients upon mineralization would have increased the concentration of micronutrients in soil and forming soluble complex by organic ligands through dissolution process and also addition of higher root biomass and leaf litter from preceding rice crop which may be attributed for increase in the micronutrient availability in the soil. Similarly, the present study results are in line with the findings of Gomma*et al*. (2015) and Katkar*et al*. (2011) who reported that, the integrated use of fertilizer with FYM increased the micronutrient availability. Similarly, Almaz and Martini (2020) who revealed that residual poultry manure and crop residue from the previous crop can improve in soil micronutrient content and soil organic matter in succeeding crop.

Correlation among growth and yield components

Path diagram and correlation matrix between grain yield and growth and yield related attributes due to the residual effect of different approaches, forms, doses and intervals of fertilizer application (Fig. 1). The relationship between grain yield and growth and yield related attributes were showed highly significant relationship with grain yield. Likewise, correlation matrix between soil organic carbon and macro and micronutrients due to the residual effect of different approaches, forms, doses and intervals of fertilizer application. The relationship between organic carbon and available NPK were showed highly significant relationship with organic carbon (Fig. 2).

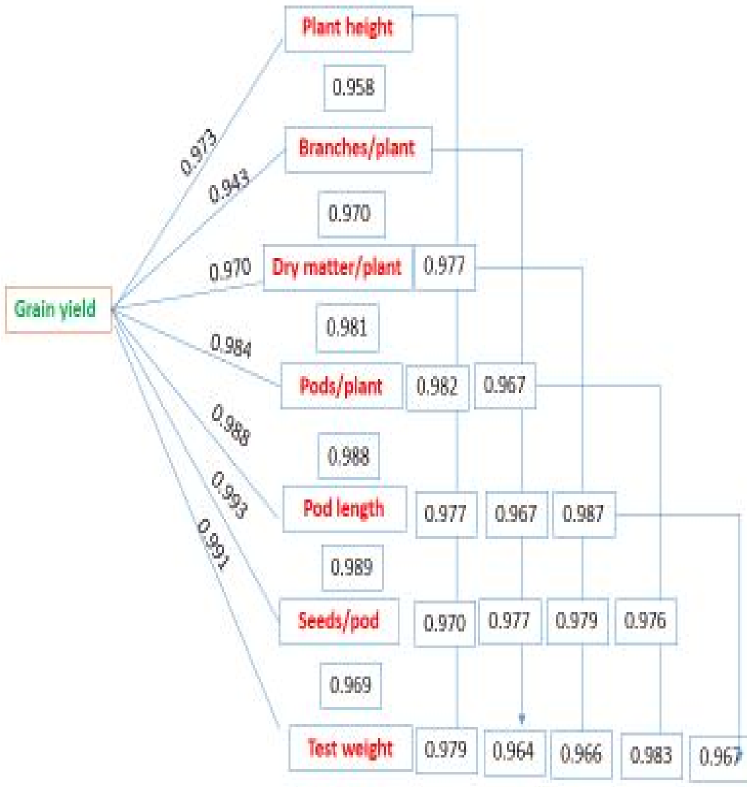

Fig. 1: Path diagram and correlation matrix between grain yield and growth and yield related attributes due to the residual effect of different approaches, forms, doses and intervals of fertilizer application

Pic 1:Path diagram and correlation matrix between grain yield and growth and yield related attributes due to the residual effect of different approaches, form does and intervals of fertilizer application

Correlation among OC with available macro and micro nutrients

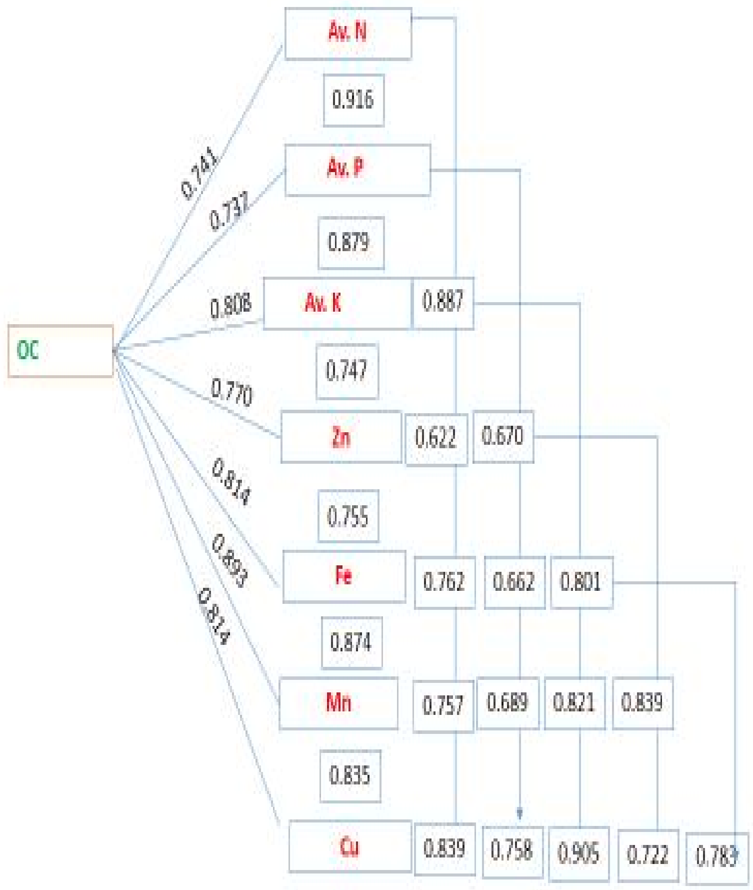

Fig. 2: Path diagram and correlation matrix between soil organic carbon and macro and micronutrients due to the residual effect of different approaches, forms, doses and intervals of fertilizer application

Pic 2:Path diagram and correlation matrix between soil organic carbon and macro and micronutrients due to the residual effect of different approaches, forms, doses and intervals of fertilizer application

Conclusion

It could be concluded that, under the conditions of this investigation, it can be recommended by cultivate, the cowpea plants at 100% RDF through water soluble fertilizer at 8 DI obtained superior effects ongrowth components, seed yield and its components. Contrary to that 100% STCR dose with WSF through fertigation at 8 DI and 100% water soluble fertilizers (WSF) applied at 4 DI recorded the higher available N, P_2O_5 and K_2O content. However, exchangeable calcium, magnesium and available sulphur in soil were recorded with 100%

conventional fertilizers applied plots through PoP. Ultimately supplement of water soluble fertilizer through drip fertigation improves the soil quality, fertility and health during in both years of the experimentation.

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 the writing or editing of this manuscript.

REFERENCES

AbayomiTV, Ajibade OF, Sammuel, Saadudeen BF. Growth and yield responses of cowpea (Vigna unguiculata (L.) Walp) genotypes to nitrogen fertilizer (NPK) application in the southern guinea Savanna zone of Nigeria. Asian Journal of Plant Science. 2008;7:170-176.

Aboamera MA. Response of cowpea to water deficit under semi-portable sprinklerirrigation system. Mysore Journal of Agricultural Engineering. 2010;27(1):170-190.

Almaz, Martini. Effects of residual organic manure and supplemental inorganic fertilizers on performance of subsequent maize crop and soil chemical properties. International Journal of Research Studies Agriculture Sciences. 2020;6(1):1-9.

BharadwajV,Omanwar PK. Long-term effects of continuous rotational cropping and fertilization on crop yields and soil properties II. Effects on EC, pH, organic matter and available nutrients of soil. Journal of Indian Society and Soil Science. 1994;42: 387-392.

Chandrakanth. STCR approach for soil and foliar application of soluble fertilizers and their effect on soil properties, growth and yield of maize. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Bangalore.2015.

DasilaB, Singh V, Kushwaha HS, Srivastava A, RamS. Water use efficiency and yield of cowpea and nutrient loss in lysimeter experiment under varying water table depth, irrigation schedules and irrigation method. SAARC Journal of Agriculture. 2016;14(2):46-55.

DugjeIY, Omoigui LO, Ekeleme F, Kamara AY, Ajeigbe H. Farmers' Guide to Cowpea Production in West Africa. IITA: Ibadan, Nigeria. 20. 2009.

FaloyeOT,Alatise MO. Effect of varying water applications on evapotranspiration and yield of cowpea under sprinkler irrigation system. International Journal of Agriculture and Crop Sciences. 2015;8(3): 307.

Gomma MA, Rawdan FI, Kandil EE, Shawer MAM. Impact of micronutrients and bio-fertilization on yield and quality of rice. Middle East Journal of Agricultural Research.2015;4:919-924.

HsiaoTC, Acevedo E. Plant response to water deficits, water use efficiency, and drought resistance. Agric. Meteorology. 1974;14:59-84.

KatkarRN, Sonune BA, Kadu PR. Long term fertilization on soil chemical and biological characteristics and productivity under sorghum (sorghum bicolour)- wheat (Triticum aestivum). Indian Journal of Agricultural Sciences. 2011;81:734-739.

Lingaraju, Bhaskar S, Geetha KN, Sathish A. Residual effect of treated sugar mill effluent irrigation with nutrient management approaches on productivity of cowpea in maize-cowpea cropping system. International Journal of Chemical Studies. 2018;6(6):274-279.

OnuhMO, Donald KM. Effect of water stress on the rooting, nodulationpotentials and growth of cowpea (Vigna unguiculata (L) WALP). Science World Journal. 2009;4(3):31-34.

PunithaBC. Influence of enriched urban solid waste compost on soil properties, yield and uptake of nutrients in cereal-pulse cropping system. Ph.D. Thesis, University of Agricultural Sciences, Bangalore.2016.

SanthiR, Selvakumari G. Effect of soil fertility and integrated plant nutrition system on yield and nutrient uptake by crops in ricebased cropping sequences. Indian Journal of Agricultural Research. 1999;33(2):129-135.

SanthoshaVP. Yield maximization in maize through different forms of fertilizers and approaches of nutrient recommendations. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Bangalore, Karnataka, India.2013.

Shruthi. Effect of graded levels of major nutrients and different sources of organic manures on soil properties and crop performance in hybrid rice-cowpea cropping system. Ph.D. Thesis, University of Agricultural Sciences, Bangalore.2017.

SundareshR. Development of STCR targeted yield equation for cabbage (Brassica oleraceae) under fertigation with soluble fertilizers and its evaluation. Ph.D. Thesis, University of Agricultural Sciences, Bangalore.2019.

Jayanthi T, PK Basavaraja, Nagaraju, RC Gowda, BC Mallesh and NB Prakash. Nutrient use efficiency as influenced by fertigation of water soluble fertilizers in aerobic rice. The Pharma Innovation Journal 2023; 12(2): 1175-1183

Table 2: Effect of fertigation of water soluble fertilizers on growth parameters of cowpea underrice-cowpea cropping sequence

Treatments	Plant height (cm)	Number of branches plant^{-1}	Total dry matter accumulation plant^{-1}
T_1-Control	37.83	8.44	44.52
T_2-100% RDF-CF	49.44	10.40	57.23
T_3-100%RDF-CF 4 DI	53.86	10.77	65.57
T_4-100%RDF-CF 8 DI	54.15	11.07	63.71
T_5-100%RDF-WSF 4 DI	57.69	11.53	69.87
T_6-50%RDF-WSF 4 DI	54.10	10.82	66.46
T_7-30%RDF-WSF 4 DI	44.78	10.03	61.31
T_8-100%RDF-WSF 8 DI	58.47	11.71	70.60
T_9-50%RDF-WSF 8 DI	54.38	10.75	65.32
T_{10}-30% RDF-WSF 8 DI	44.77	10.07	61.13
T_{11}-100%STCR dose-WSF 4 DI	55.67	11.05	67.71
T_{12}-50%STCR dose -WSF 4 DI	53.64	10.63	64.71
T_{13}-30%STCR dose -WSF 4 DI	45.37	10.20	60.97
T_{14}-100%STCR dose -WSF 8 DI	56.30	11.09	67.17
T_{15}-50%STCR dose -WSF 8 DI	53.99	10.75	65.39
T_{16}-30%STCR dose -WSF 8 DI	44.95	9.66	61.40
SEm ±	**2.12**	**0.35**	**01.86**
CD at 5%	**5.99**	**0.99**	**05.27**

RDF: Recommended dose of fertilizer, STCR: Soil test crop response, WSF: Water soluble fertilizers, CF: Conventional fertilizers, DI: Days interval, NS: Non significant

Table 3: Effect of fertigation of water soluble fertilizers on yield parameters of cowpea under rice-cowpea cropping sequence

Treatments	Number of pods plant^{-1}	Pod length (cm)	Number of seeds pod^{-1}	Test weight (g)
T_1-Control	9.96	12.19	9.09	8.36
T_2-100% RDF-CF	11.83	14.49	12.40	9.72
T_3-100%RDF-CF 4 DI	13.73	15.47	13.73	10.07
T_4-100%RDF-CF 8 DI	12.60	14.93	14.47	11.08
T_5-100%RDF-WSF 4 DI	16.40	16.34	16.08	11.85
T_6-50%RDF-WSF 4 DI	14.30	15.96	14.88	11.09
T_7-30%RDF-WSF 4 DI	11.97	13.83	12.77	10.37
T_8-100%RDF-WSF 8 DI	16.58	16.67	16.10	11.93
T_9-50%RDF-WSF 8 DI	14.25	16.33	14.48	11.07
T_{10}-30% RDF-WSF 8 DI	12.20	13.57	11.61	9.61
T_{11}-100%STCR dose-WSF 4 DI	16.13	16.63	15.63	11.66
T_{12}-50%STCR dose -WSF 4 DI	14.37	15.61	14.63	10.84
T_{13}-30%STCR dose -WSF 4 DI	11.13	13.16	12.26	9.90
T_{14}-100%STCR dose -WSF 8 DI	15.47	16.65	15.57	11.48
T_{15}-50%STCR dose -WSF 8 DI	13.77	16.05	14.46	10.92
T_{16}-30%STCR dose -WSF 8 DI	12.00	13.71	11.97	10.32
SEm ±	**0.83**	**0.27**	**0.59**	**0.41**
CD at 5%	**2.34**	**0.77**	**1.68**	**1.16**

RDF: Recommended dose of fertilizer, STCR: Soil test crop response, WSF: Water soluble fertilizers, CF: Conventional fertilizers, DI: Days interval, NS: Non significant

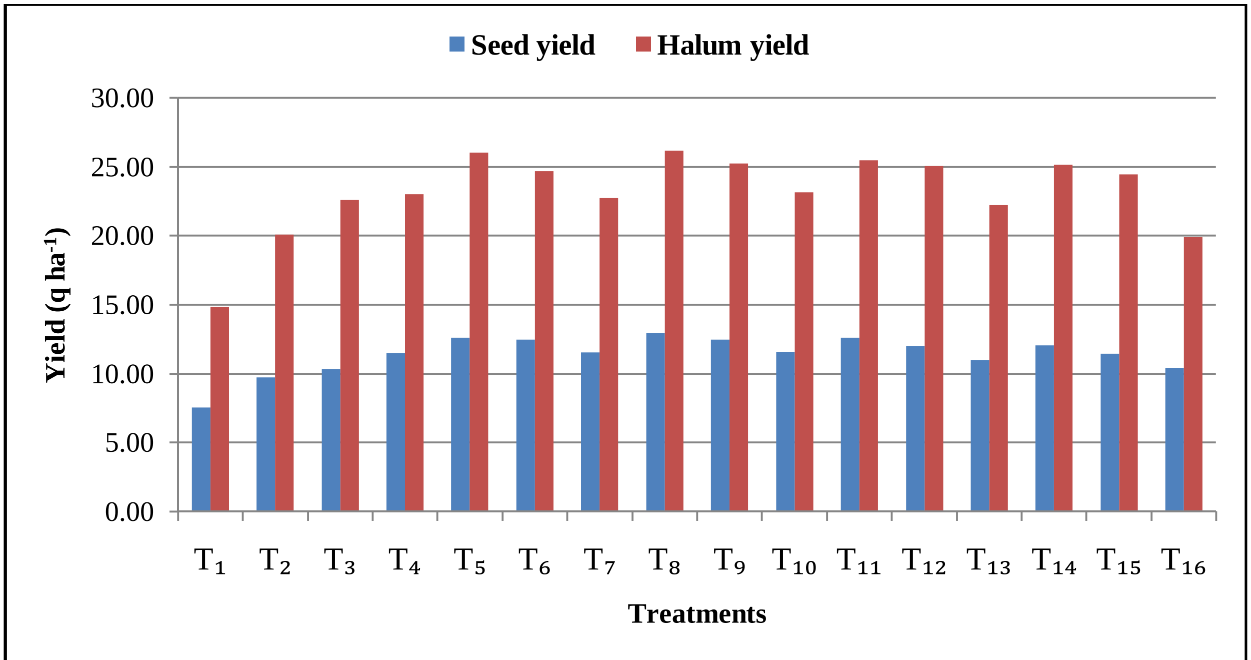

Fig 1: Effect of fertigation of water soluble fertilizers on seed and haulm yield of cowpea under rice-cowpea cropping sequence

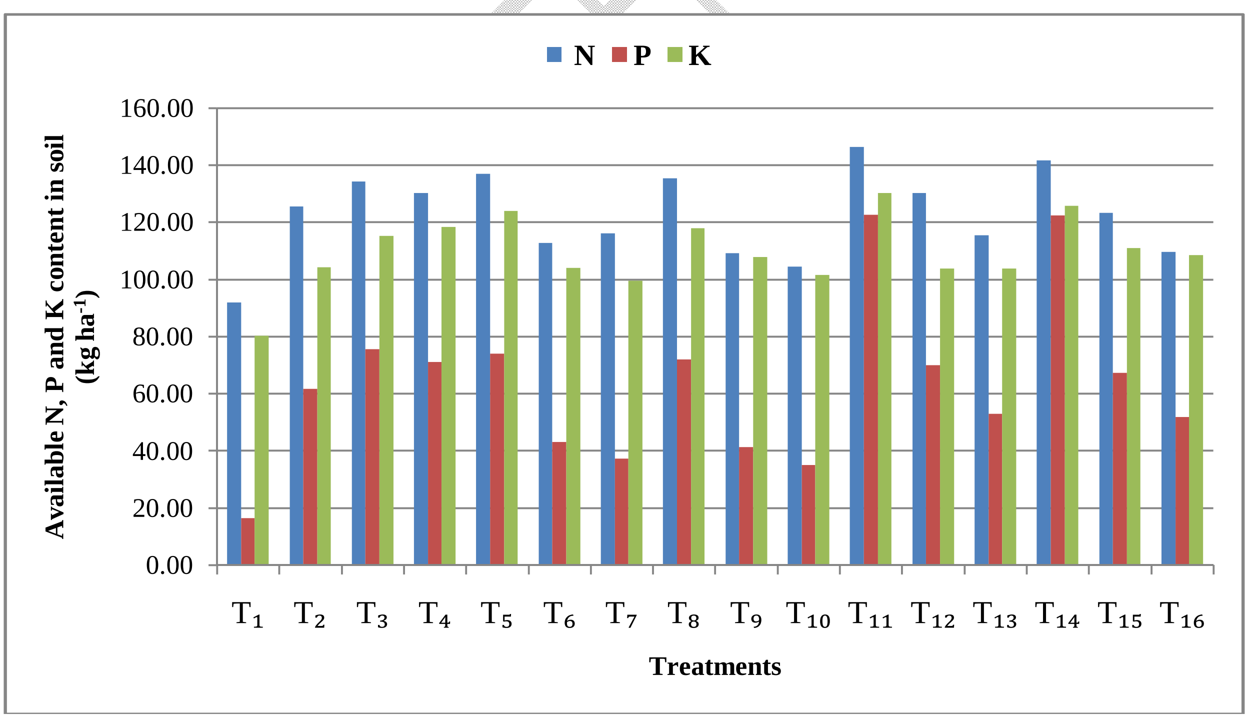

Fig 2: Effect of fertigation of water soluble fertilizers on primary nutrient content in soil after harvest of cowpea under rice-cowpea cropping sequence

Table 4: Effect of fertigation of water soluble fertilizers on pH, EC, OC content in soil after harvest of cowpea under rice-cowpea cropping sequence

Treatments	pH	EC (dS m^{-1})	Organic carbon (%)
	(1:2.5)		
T_1-Control	6.84	0.16	0.44
T_2-100% RDF-CF	6.83	0.18	0.50
T_3-100% RDF-CF 4 DI	6.82	0.17	0.49
T_4-100% RDF-CF 8 DI	6.92	0.13	0.50
T_5-100% RDF-WSF 4 DI	6.90	0.14	0.54
T_6-50% RDF-WSF 4 DI	6.91	0.12	0.49
T_7-30% RDF-WSF 4 DI	6.89	0.13	0.43
T_8-100% RDF-WSF 8 DI	6.88	0.12	0.57
T_9-50% RDF-WSF 8 DI	6.92	0.15	0.50
T_{10}-30% RDF-WSF 8 DI	6.88	0.14	0.50
T_{11}-100% STCR dose -WSF 4 DI	6.87	0.16	0.56
T_{12}-50% STCR dose -WSF 4 DI	6.91	0.15	0.50
T_{13}-30% STCR dose -WSF 4 DI	6.98	0.13	0.47
T_{14}-100% STCR dose -WSF 8 DI	6.92	0.13	0.54
T_{15}-50% STCR dose -WSF 8 DI	7.00	0.17	0.48
T_{16}-30% STCR dose -WSF 8 DI	6.99	0.15	0.48
SEm ±	**0.07**	**0.02**	**0.02**
CD at 5%	**NS**	**NS**	**0.07**

RDF: Recommended dose of fertilizer, STCR: Soil test crop response, WSF: Water soluble fertilizers, CF: Conventional fertilizers, DI: Days interval, NS: Non significant

Table 5: Effect of fertigation of water soluble fertilizers on secondary nutrient content in soil after harvest of cowpea under rice-cowpea cropping sequence

Treatments	Exch. Ca	Exch. Mg	Avail. S
	[cmol (p+) kg^{-1}]		(mg kg^{-1})
T_1-Control	2.63	1.68	10.04
T_2-100% RDF-CF	3.51	2.55	12.50
T_3-100% RDF-CF 4 DI	3.40	2.40	12.04
T_4-100% RDF-CF 8 DI	3.31	2.52	12.41
T_5-100% RDF-WSF 4 DI	3.32	2.49	12.09
T_6-50% RDF-WSF 4 DI	2.74	2.39	10.12
T_7-30% RDF-WSF 4 DI	2.58	1.41	10.16
T_8-100% RDF-WSF 8 DI	3.39	2.53	12.45
T_9-50% RDF-WSF 8 DI	2.60	2.34	10.23
T_{10}-30% RDF-WSF 8 DI	2.40	1.37	10.22
T_{11}-100% STCR dose -WSF 4 DI	3.19	2.38	11.80
T_{12}-50% STCR dose -WSF 4 DI	2.44	2.22	10.24
T_{13}-30% STCR dose -WSF 4 DI	2.35	1.43	10.05
T_{14}-100% STCR dose -WSF 8 DI	3.33	2.39	11.52
T_{15}-50% STCR dose -WSF 8 DI	2.47	2.28	10.25
T_{16}-30% STCR dose -WSF 8 DI	2.29	1.46	10.09
SEm ±	**0.12**	**0.09**	**0.25**
CD at 5%	**0.33**	**0.26**	**0.71**

RDF: Recommended dose of fertilizer, STCR: Soil test crop response, WSF: Water soluble fertilizers, CF: Conventional fertilizers, DI: Days interval, NS: Non significant

Table 6: Effect of fertigation of water soluble fertilizers on DTPA extractable micronutrients content in soil after harvest of cowpea under rice-cowpea cropping sequence

Treatments	DTPA extractable micronutrients ($mg\ kg^{-1}$)			
	Fe	**Zn**	**Mn**	**Cu**
T_1-Control	13.70	1.08	17.89	0.40
T_2-100% RDF-CF	15.86	1.33	20.14	0.51
T_3-100% RDF-CF 4 DI	16.50	1.33	20.22	0.51
T_4-100% RDF-CF 8 DI	15.64	1.36	21.12	0.52
T_5-100% RDF-WSF 4 DI	18.38	1.36	22.76	0.55
T_6-50% RDF-WSF 4 DI	17.78	1.31	21.55	0.49
T_7-30% RDF-WSF 4 DI	13.98	1.13	18.88	0.49
T_8-100% RDF-WSF 8 DI	17.58	1.44	22.70	0.57
T_9-50% RDF-WSF 8 DI	17.53	1.28	21.27	0.50
T_{10}-30% RDF-WSF 8 DI	16.21	1.16	19.49	0.49
T_{11}-100% STCR dose -WSF 4 DI	18.35	1.37	22.78	0.56
T_{12}-50% STCR dose -WSF 4 DI	17.10	1.29	21.37	0.51
T_{13}-30% STCR dose -WSF 4 DI	17.04	1.26	20.01	0.51
T_{14}-100% STCR dose -WSF 8 DI	18.45	1.33	21.71	0.54
T_{15}-50% STCR dose -WSF 8 DI	17.80	1.29	20.08	0.51
T_{16}-30% STCR dose -WSF 8 DI	16.11	1.23	20.11	0.52
SEm ±	**0.67**	**0.06**	**0.39**	**0.03**
CD at 5%	**1.89**	**0.16**	**1.10**	**0.07**

RDF: Recommended dose of fertilizer, STCR: Soil test crop response, WSF: Water soluble fertilizers, CF: Conventional fertilizers, DI: Days interval, NS: Non significant