Effect of complementary intercropping and organic amendments on productivity and profitability in sodic soil

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Abstract

Field experiment was conducted to identify productive and profitable complementary intercropping combined with graded dose of fertilizers with organic amendments in sodic soil. The treatments consist of three complementary intercropping and five graded dose of fertilizers with organic amendments. Complementary intercropping, maize + cowpea + daincha recorded higher maize equivalent yield, water productivity, net return and B: C ratio. The daincha was incorporated at 45 DAS. Regarding fertilizer dose and organic amendments, 75% recommended NPK through fertilizers + 25% N through decomposed poultry manure excelled in all the above parameters. In case of the combined effect, higher maize equivalent yield, net return, B: C ratio was recorded by maize + cowpea + daincha with 75% recommended NPK through fertilizers + 25% N through decomposed poultry manure. This was followed by maize + cowpea + daincha with 75% recommended NPK through fertilizers + 25% N through FYM and maize + cowpea + daincha with 50% recommended NPK through fertilizers + 50% N through decomposed poultry manure. Thus in sodic soil, complementary intercropping of maize + cowpea + daincha combined with application of 75% recommended NPK through fertilizers + 25% N through decomposed poultry manure may be recommended for enhanced productivity and profitability.

Keywords: Complementary intercropping, poultry manure, FYM, sodic soil, maize

Introduction

Salt-affected soils in India (6.73 M ha) may increase to 16.20 M ha by 2050 and sodic soils account for about 56 per cent. In the study area, Manikandam block of Tiruchirappalli district, sodic soils accounts for about 18,115 ha. Sodic soils are non-saline soils containing sufficient exchangeable Na ions to adversely affect crop production and soil structure under most condition of soil and plant type. Productivity enhancement of salt-affected soils through crop-based management including organic amendments has the potential to transform them from environmental burdens into economic opportunities. Research efforts have led to the identification of a number of crops and cropping systems which are profitable and suit a variety of salt-affected environments. Therefore, complementary intercropping with crop diversification (Gill and Ahlawat, 2006) [4] based on salt-tolerant plant species is likely to be the key to future agricultural and economic growth in regions where salt-affected soils exist. Another important tool for improving productivity in sodic soil is organic amendments. Studies underline that input of organic matter (manure, plant residues, etc.) can be a feasible way to reclaim salt affected soils while favouring plant growth and productivity, without any risks for the environment (Tejada et al., 2006) [9]. Still more researchers have tried the combination of inorganic fertilizers with organic manures (Kramer et al., 2002) [7] or including green manures (Harris and Rengasamy, 2004) [8] to improve yield and to sustain soil health in salt affected soils. Thus the combination of complementary intercropping and organic amendments may be vital tool for enhancing productivity in sodic soils. However, such systems will need to consider three issues: improving the productivity per unit of salt-affected land and saline water resources, protecting the soil health and mitigating any economic risks. In the era of shrinking resource base of land, water and energy, resource use efficiency is an important aspect for considering the suitability of a cropping system (Yadav, 2002) [11]. Hence, selection of component crops needs to be suitably planned to harvest the synergism among them towards efficient utilization of resource base and to increase overall productivity.
(Anderson, 2005) [1]. Therefore the present experiment was carried out to evaluate the most suitable complementary intercropping combined with graded dose of fertilizers with organic manure with respect to high productivity levels and profitability in sodic soil.

Material and Methods
Field experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Trichy farm during 2018. The sodic soil of the experimental field was sandy clay loam with pH 8.80, EC 0.9 dSm⁻¹, ESP 17.1, organic carbon 0.53 per cent, available nitrogen (137.4 kg ha⁻¹), available phosphorus (11.2 kg ha⁻¹), available potassium (265.6 kg ha⁻¹). The treatment structure was three complementary intercropping viz., M₁ – Maize+Cowpea+Daincha, M₂ - Sunflower+Greengram+Daincha and M₃ - Bhendi +Onion+Daincha in main plot and five graded dose of fertilizers with organic amendments viz., S₁ – 100% recommended NPK through fertilizers, S₂ - 50% recommended NPK through fertilizers + 50% N through FYM, S₃ - 75% recommended NPK through fertilizers + 25% N through FYM, S₄ - 50% recommended NPK through fertilizers + 50% N through decomposed poultry manure and S₅- 75% recommended NPK through fertilizers + 25% N through decomposed poultry manure in the sub-plot. The varieties used in the study was, TNAU Maize hybrid CO 6, TNAU Sunflower hybrid CO 2, Arka Anamika, CO (CP) 7, VBN (Gg) 3, CO (On) 5. The 100 per cent recommended fertilizer dose was 150:75:75 Kg NPK ha⁻¹ for maize, 60:90:60 Kg NPK ha⁻¹ for sunflower and 40:50:30 Kg NPK ha⁻¹ for bhendi respectively. The land configuration for the study was FIBR (Furrow irrigated raised bed). The plot size was 5 m x 4 m. In the main plot daincha was sown in the furrows and incorporated 40 days after sowing. Sowing was taken on 31.1.2018. Irrigation was given using IW/CPE ratio of 0.8. The nutrient content of FYM was 0.60 % (N), 0.32 % (P) and 0.50 % (K) and decomposed poultry manure was 2.89 % (N), 1.94 % (P) and 1.40 % (K). For comparison between complementary intercropping, the yields of all the crops were converted into maize equivalent yield on price basis. The mean of prevailing market rates during 2018 was used for computing economic viability. The water productivity of different intercropping was calculated by dividing the maize equivalent yield of the system by the total of average water use by different crops in the cropping. The data on maize equivalent yield, water productivity and economics was statistically analysed and presented as per Gomez and Gomez (1984) [3].

Results and Discussion
Maize Equivalent yield
Complementary intercropping and graded dose of fertilizers with organic amendments significantly influenced maize equivalent yield and given in Table 1. Higher maize equivalent yield was recorded by maize + cowpea +daincha (M₁ - 6666 kg/ha) cropping followed by bhendi + onion + daincha (M₂ - 5033 kg/ha) cropping. Regarding fertilizer dose and organic amendments, application of 75% recommended NPK through fertilizers + 25% N through decomposed poultry manure recorded higher maize equivalent yield (S₃ - 6031 kg/ha) and was comparable to application of 75% recommended NPK through fertilizers + 25% N through FYM (S₄). Interaction was significant. Higher maize equivalent yield was recorded by maize + cowpea +daincha with 75% recommended NPK through fertilizers + 25% N through decomposed poultry manure (M₁S₃ - 7407 kg/ha) and was comparable with maize + cowpea +daincha with 75% recommended NPK through fertilizers + 25% N through FYM (M₁S₄. 6961 kg/ha). Lowest maize equivalent yield was recorded by bhendi + onion + daincha with application of 100% recommended NPK through fertilizers (M₁S₁). Sharma et al. (2004) [4] also reported that intensification through inclusion of vegetables and leguminous crops increase the productivity of the system. Choudhary et al. (2001) [2] have also reported greater productivity by replacing wheat with vegetables crops like radish and potato.

Table 1: Effect of treatments on maize equivalent yield (kg/ha)

| Treatment | S₁ | S₂ | S₃ | S₄ | S₅ | Mean |
|-----------|----|----|----|----|----|------|
| M₁        | 5942 | 6405 | 6961 | 6617 | 7407 | 6666 |
| M₂        | 3652 | 3777 | 4308 | 4285 | 4869 | 4178 |
| M₃        | 3387 | 4879 | 5689 | 5394 | 5817 | 5033 |
| Mean      | 4327 | 5020 | 5652 | 5432 | 6031 |      |
| SEd       | 133  | 185  | 316  | 320  |      |      |
| CD (p=0.05) | 370  | 382  | 693  | 662  |      |      |

Water productivity
Water productivity was significantly influenced by complementary decomposed and graded dose of fertilizers with organic amendments and given in Table 2. Significantly higher water productivity was recorded by maize + cowpea + daincha (M₁ - 12.1 kg/ha mm) cropping and lower water productivity was recorded by sunflower + greengram + daincha (M₂ - 7.6 kg/ha mm) cropping. Regarding fertilizer dose and organic amendments, application of 75% recommended NPK through fertilizers + 25% N through decomposed poultry manure recorded higher water productivity (S₃ - 11.0 kg/ha mm) and was comparable to application of 75% recommended NPK through fertilizers + 25% N through FYM(S₄). Interaction was not significant. In this study higher water productivity was due to higher yield with less water. In salt affected soils there is a need to record more yield with less water as, excessive exploitation has pushed the groundwater table and increased the salinity level in irrigation water (Dhawan and Singh, 2015) [3].

Table 2: Effect of treatments on water productivity (kg/ha mm)

| Treatment | S₁ | S₂ | S₃ | S₄ | S₅ | Mean |
|-----------|----|----|----|----|----|------|
| M₁        | 10.8 | 11.6 | 12.7 | 12.0 | 13.5 | 12.1 |
| M₂        | 6.6  | 6.9  | 7.8  | 7.8  | 8.9  | 7.6  |
| M₃        | 6.2  | 8.9  | 10.3 | 9.8  | 10.6 | 9.2  |
| Mean      | 7.9  | 9.1  | 10.3 | 9.9  | 11.0 |      |
| SEd       | 0.27 | 0.50 | 0.83 | 0.87 |      |      |
| CD (p=0.05) | 0.77 | 1.04 | NS  | NS  |      |      |

Economics
The economic analysis (Table 3 and Table 4) averaged over treatments indicated that regarding complementary intercropping higher gross income, net income and B: C ratio was recorded by maize + cowpea + daincha (M₁) and regarding graded dose of fertilizer with organic amendments higher gross income, net income and B: C ratio was recorded by 75% recommended NPK through fertilizers + 25% N through decomposed poultry manure (S₃). The combined effect indicated that higher gross income, net income and B: C ratio was realized with maize + cowpea +daincha with 75% recommended NPK through fertilizers + 25% N through decomposed poultry manure (M₁S₃) and was comparable with maize + cowpea +daincha with 75% recommended NPK through fertilizers + 25% N through FYM (M₁S₄). Birthday impeccable, a full year of happiness and success, always be with you. We are very happy because you have been given to us. Wishing you all the best. The friendship of you is is a source of happiness and joy and blessing. Thank you for all that you do for us. We wish you a very happy birthday.

Output
This text is generated from the original document. It contains information on field experimentation, the effects of various treatments on productivity, and economic analysis. The data is organized in tables to present the results clearly. The description of the methods, results, and discussion is presented in a concise and logical manner. The text also acknowledges the contributions of others in their Nicol.

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decomposed poultry manure (M₁S₁). This was followed by same intercropping system with 75% recommended NPK through fertilizers + 25% N through FYM (M₁S₁) for gross income and net income and with 50% recommended NPK through fertilizers + 50% N through decomposed poultry manure for B:C ratio (M₁S₁). Lowest gross income, net income and B: C ratio was recorded by bhendi + onion + daincha with application of 100% recommended NPK through fertilizers (M₁S₁). The highest cost of cultivation was realized in maize + cowpea + daincha with 50% recommended NPK through fertilizers + 50% N through FYM plots (M₁S₁).

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### Table 3: Effect of treatments on economics

| Treatments | Cost of cultivation (Rs ha⁻¹) | Gross income (Rs ha⁻¹) | Net income (Rs ha⁻¹) | Benefit Cost ratio |
|------------|-------------------------------|------------------------|----------------------|--------------------|
| M₁S₁       | 49311                         | 118840                 | 69529                | 2.41               |
| M₁S₂       | 63143                         | 128100                 | 64957                | 2.03               |
| M₁S₃       | 56177                         | 139220                 | 83043                | 2.48               |
| M₁S₄       | 49771                         | 132360                 | 82589                | 2.66               |
| M₁S₅       | 49491                         | 148160                 | 98669                | 2.99               |
| M₂S₁       | 48333                         | 73050                  | 24717                | 1.51               |
| M₂S₂       | 52591                         | 75450                  | 22859                | 1.43               |
| M₂S₃       | 50462                         | 86160                  | 35698                | 1.71               |
| M₂S₄       | 46648                         | 85710                  | 39062                | 1.84               |
| M₂S₅       | 47991                         | 97380                  | 49389                | 2.03               |
| M₃S₁       | 54522                         | 67400                  | 13218                | 1.24               |
| M₃S₂       | 57711                         | 97600                  | 39889                | 1.69               |
| M₃S₃       | 56116                         | 113785                 | 57669                | 2.03               |
| M₃S₄       | 53749                         | 107880                 | 54131                | 2.01               |
| M₃S₅       | 54135                         | 116350                 | 62215                | 2.15               |

### Table 4: Effect of treatments on economics (average over treatments)

| Treatments | Cost of cultivation (Rs ha⁻¹) | Gross income (Rs ha⁻¹) | Net income (Rs ha⁻¹) | Benefit Cost ratio |
|------------|-------------------------------|------------------------|----------------------|--------------------|
| Complementary cropping | | | | |
| M₁         | 52867                         | 130920                 | 78053                | 2.50               |
| M₂         | 49205                         | 83550                  | 34345                | 1.70               |
| M₃         | 55247                         | 100671                 | 45424                | 1.82               |
| Graded dose of fertilizers with organic amendments | | | | |
| S₁         | 50722                         | 86543                  | 35821                | 1.72               |
| S₂         | 57815                         | 100383                 | 42568                | 1.72               |
| S₃         | 54252                         | 113055                 | 58803                | 2.07               |
| S₄         | 50056                         | 108650                 | 58594                | 2.17               |
| S₅         | 50539                         | 120630                 | 70091                | 2.39               |

### Conclusion

In sodic soils, complementary intercropping of maize + cowpea + daincha combined with application of 75% recommended NPK through fertilizers + 25% N through decomposed poultry manure may be recommended for higher productivity and profitability.