



Comparative studies of conventional, organic and natural farming types for their efficiency, and productivity in maize + red gram intercropping system

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Summary

The field experiment on comparative studies of different farming methods for their efficiency and productivity in maize + redgram intercropping system was conducted at zonal agricultural and horticultural research station, Bhavikere during Kharif season. Among the different farming types, growth and yield parameters of maize viz. plant height (204.18 cm) number of leaves/ plant (17.20), cob length (15.94cm), straw yield (19.35 t/ ha) grain yield (81.36 q/ ha) and red gram Grain yield (4.36 q/ ha) and straw yield (11.19 q/ ha) were significantly higher with treatment received nutrients as per package of practices as compared to natural farming and organic farming treatments. Similar trend was observed with maize equivalent yield (95.50 q/ ha). On the other hand, highest dehydrogenase (14.32, 28.65, 24.19 and 16.23 µg TPF/ g soil/ day) and urease (4.12, 12.65, 7.14 and 3.32 µg NH₄-N/ g /soil/ 2 hrs) enzyme activity was observed in organic farming treatment at 30, 60, 90 DAS and at harvest, respectively followed by natural farming treatment and least enzyme activity was noticed in farmers practice. Same trend was observed in acid and alkaline phosphatase enzyme activities. There was no much variation in physical properties i.e., bulk density, particle density, maximum water holding capacity and porosity by the different treatments and also no significant difference occurs in the pH and EC, however higher nitrogen (315.27) phosphorus (73.48) and potassium (271.28) was observed in the organic farming treatment and it was followed with the farmer's practice treatment. The lowest was recorded in the natural farming treatment (215.47, 33.47 and 220.47 at the harvest stage).

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Introduction

Despite the gains of the green revolution for achieving self-sufficiency in food grain production, intensive cropping practices coupled with extensive chemical inputs usage adversely impacted the natural resource base, leading to a decline in crop productivity and food quality. Further, the farmers are directly affected by changing climate, escalating energy crisis and exorbitant agro-chemical costs. At this juncture, a keen awareness has been raised among the farming community about adopting sustainable agricultural practices. Sustainable agriculture aims to simulate nature with a holistic approach as the pattern for creating agricultural systems by nurturing diversity, integrating plants and animals into a diverse landscape for the gratification of the human requirements for today and the future. Agricultural production can only be sustained on a long-term basis if the land, water and forests on which it is based are not degraded further. The creation of multiplicity and its

effective execution for sustainable agriculture are very important and intercropping suggests simulating nature's principle of diversity on crop lands. Thus, intercropping can be evaluated as a pro-ecological approach of raising of crops, supporting above and below ground bio-diversity and compatible crop husbandry with the aims of sustainable agriculture.^{18,19} A system consists of different components and these are diligently related with a proper interaction among themselves. Cropping system refers to production of crops in sequences or mixture and the management involved in a specific field for a time period.³ Generally, farmers adopt various cropping systems to maximize farm output, profitability and production sustainability.^{4,20} The system approach always aims at better utilization of resources and agronomic manipulations and thus assures sustainable productivity as well as enhancement of cropping intensity. The intensive cropping systems focus on maximization of farm output from unit area. The modern concepts of agronomy clearly narrate that the efficiency of a cropping system hangs on the single crop in monocropping and/ or different crops cultivated in the sequential or intercropping system. Moreover, time and space dimensions are also considered to measure the efficiency of the system more accurately.^{17,21} However,

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modern agriculture resulted in mechanization, monoculture, cultivation of improved varieties and hybrids of crops, use of chemical fertilizers and nutrients led to a simplification of the interacting components in agricultural systems and ultimately caused genetic erosion, greater susceptibility to abiotic stress and thus vulnerability in cropping system. Restoration of biodiversity through growing of different crops and adoption of farming systems that result in the efficient exploitation of available resources is important for sustaining farm output.^{5,13} The modern agriculture has assured enhancement in production and productivity, but simultaneously brought uncertainty in farming with a threat to agricultural sustainability.^{15,7} In this search for eco-friendly and farmer-friendly alternate farming systems, viz., organic farming and Natural Farming system is increasingly becoming popular among the farming community. Maize is a predominant crop of this region, being grown in an area of 1.4 mha as a sole crop. Growing maize as a sole crop continuously affects soil fertility and health besides reduction in yield. This region introduces the maize+red gram intercropping system to sustain soil maize production. Under this system, different farming types are assessed to know their potentiality in getting higher and sustainable yield with improved soil fertility and health.

Material and Methods

Table 1. Treatment details for maize + red gram intercropping system

Treatments	Seed treatment	Nutrient management
Natural farming (NF)	Beejamrutha	Ghanajeevamrutha 400kg/acre, Jeevamrutha 200 lit/acre (every 30 days intervals) with mulching
Organic farming (OF)	Rhizobium 150 g/ acre + PSB 400 g/ acre	Recommended dose of FYM + N equivalent basis of FYM
Package of practice (POP)	Rhizobium 150 g/ acre + PSB 400 g/ acre	The recommended dose of FYM and NPK 40:20:10 kg/acre
Farmer's practice (FP)	-	Two-tone of FYM and NPK @ 76:20:18 kg/acre

Results and Discussion

Growth parameters and yield parameters of maize and red gram

Growth and yield parameters of maize and red gram viz. plant height (204.18cm) number of leaves per plant (17.20), cob length (15.94cm), straw yield (19.35 t/ha) and grain yield (81.36 q/ha) were significantly higher with treatment received nutrients as per package of practices as compared to natural Farming and organic farming treatments. Seed yield (4.36 q/ha) and stover yield (11.19 q/ha) of red gram intercropped with maize was higher with treatment package of practices followed by farmers practice treatment (11.19 q/ha), lower seed yield (3.68 q/ha) was found in natural farming type as compared to other farming types. The data on maize equivalent yield (95.50 q/ha) (Table 2) was also higher with the treatment application of nutrients through a recommended dose of FYM and fertilizers. The increase in yield and yield attributing characters with applying nutrients through FYM and fertilizers might be attributed to the quick release and availability of nutrients in the

A field experiment on "Comparative studies of different farming practices for their efficiency and productivity in maize + redgram are intercropping system" was conducted at the Zonal Agricultural and Horticultural research station, Bhavikere during *Kharif* season of 2020-21 comprised of 4 treatments with five replications and the experiment was laid out in RCBD. The treatment details are given in Table 1. The research area was located at 13° 43' N latitude and 75° 43' E longitude with an altitude of 695 MSL. Bold and healthy seeds of Maize (P-3401) and red gram (BRG-4) was selected for sown at 4:2 ratios. The plant population was maintained by gap-filling one week after sowing. The thinning attended 20 DAS to maintain a uniform plant population. For Biometric observations, five plants from each plot were randomly selected and labelled for recording observations of plant height (cm) and number of leaves per plant at different growth stages viz. 30, 60, 90 DAS and at harvest. Maize and red gram yield attributing characters like number of cobs per plant, cob length (cm), number of rows per cob, number of seeds per row, number of seeds per cob and number of pods per plant, straw yield and grain yield at harvest was recorded at harvest. Soil samples were collected after the harvest of the crop. The samples were analysed for organic carbon and available N, P and K through standard procedures.

required quantity with the application of fertilizers. Further, FYM acts as store house for various micro and macro nutrients that are released during the process of mineralization Mahajan et al. (2008)⁹ and Satyanarayana et al. (2008)¹² reported that the nutrients provided through inorganic sources enhanced yield initially but led to unsustainable productivity over the years. Bokhtiar & Sakurai (2005)⁷ that the use of imbalanced nutrients through chemical fertilizer in continuous cropping leads to an imbalance of nutrients in the soil, leaching of N, contamination of water resources, decimation of microorganisms and friendly insects, crop vulnerability to disease outbreak, soil acidification or alkalization, or decreased soil fertility thus bringing permanent loss to the whole system. This is due to their susceptibility to losses in gaseous forms or by leaching when applied at a wrong time or in an excess amount beyond the plant demand. The negative effects of inorganic fertilizer coupled with their high costs have incited the interest for the utilization of organic fertilizer as a source of nutrients.

Table 2. Effect of different farming types growth, grain yield of maize and red gram and maize equivalent yield as influenced by different farming types

Treatment s	Maize						Red gram					
	Plant height (cm)	No. of leaves / plt	No. of cobs / plt	Cob length	Maize yield (q/ha)	Straw yield (t/ha)	Plant height (cm)	No. of branches / plant	No. of pods / plant	Red gram yield (q/ha)	Stover yield (q/ha)	Maize Equivalent yield (q/ha)
NF	188.76	14.40	1.40	12.26	68.23	15.23	195.35	21.52	189.23	3.68	10.12	79.52
OF	190.04	16.20	1.60	13.96	75.23	18.25	193.52	22.47	159.88	3.95	10.36	88.04
POP	204.18	17.20	1.60	15.94	81.36	19.35	197.09	24.69	197.30	4.36	11.25	95.50
FP	194.64	15.80	1.40	15.58	79.25	19.21	187.35	24.55	185.54	4.12	11.19	92.61
S. Em±	2.25	0.47	0.27	0.22	1.64	0.39	3.91	1.76	18.56	0.09	0.23	1.91
CD	9.46	1.98	NS	0.94	6.87	1.63	NS	NS	NS	0.36	0.97	2.71

Soil physical properties and Chemical properties

There was no much variation in physical properties i.e., Bulk density, particle density, maximum water holding capacity and porosity by the different treatments and also no significant difference occurs in the pH and EC, however higher nitrogen (315.27)

Phosphorus (73.48) and potassium (271.28) was observed in the organic farming treatment and it was followed with the farmer's practice treatment. Lowest was recorded in the natural farming treatment (215.47, 33.47 and 220.47 at harvest stage) (Table 3).

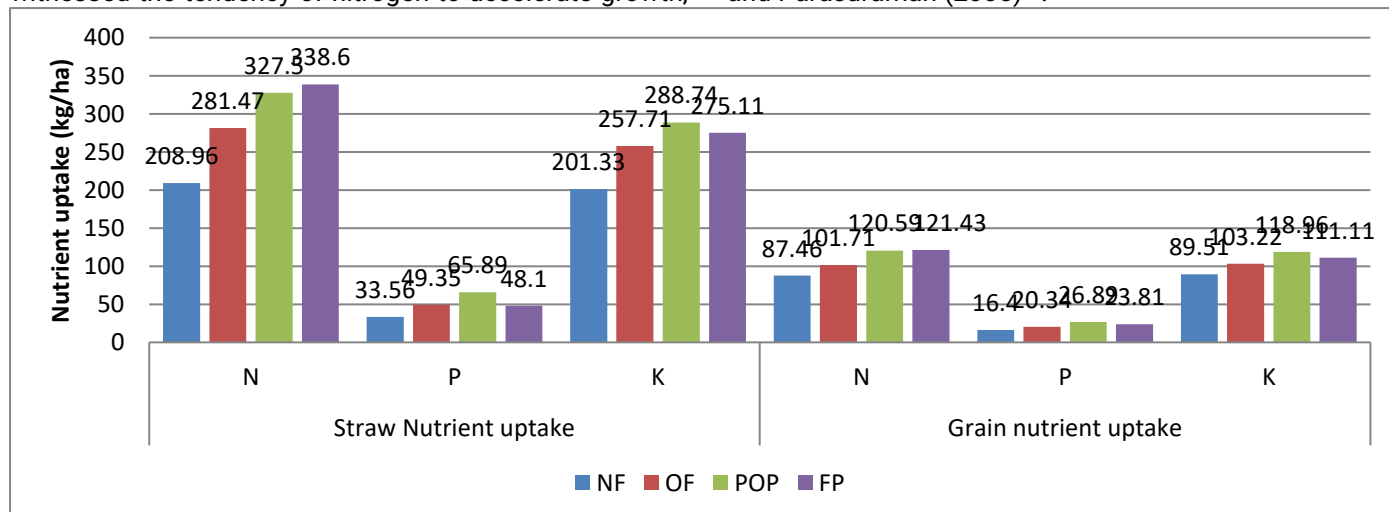
Table 3. Effect of different farming system on soil physical and chemical properties

Treatments	BD (g/cc)	PD (g/cc)	MWHC	Porosity (%)	pH	EC	OC (%)	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)
NF	1.38	2.16	14.68	35.4	5.61	0.117	0.59	215.47	33.47	220.47
OF	1.36	2.11	15.07	36.45	5.47	0.108	0.75	289.47	73.48	271.28
POP	1.41	2.15	13.78	33.62	5.78	0.133	0.63	257.64	61.74	254.47
FP	1.45	2.21	13.27	31.08	5.81	0.124	0.48	267.28	46.47	231.17
S. Em±	0.03	0.05	0.31	0.74	0.12	0.003	0.01	5.51	1.18	5.26
CD	NS	NS	0.94	2.27	NS	0.008	0.04	17.00	3.66	16.22

Total nutrient uptake

Significantly higher uptake by straw and grain nitrogen (338.6, 121.43) was recorded with farmer's practice and with respect to phosphorus and potassium, higher uptake by straw and grain (65.89, 275.11) was observed with treatment POP Fig.1. The enhanced values of yield-attributing characters witnessed the tendency of nitrogen to accelerate growth,

photosynthetic activity and translocation efficiency which might have contributed for higher uptake of nitrogen, phosphorus and potassium. This might have enhanced the vegetative growth of crop which ultimately increased nutrient concentration in total biomass of plants. The results of present investigation are in close agreement with the findings of Singh & Sarkar (2001)¹⁴ and Parasuraman (2005)¹⁰.

**Figure 1.** Effect of different farming systems on nutrient uptake

Microbial analysis

Highest dehydrogenase (14.32, 28.65, 24.19 and 16.23 $\mu\text{g TPF/g soil/day}$) and urease (4.12, 12.65, 7.14 and 3.32 $\mu\text{g NH}_4\text{-N/g soil/2 hrs}$) enzyme activity was observed in organic farming treatment at 30, 60, 90 and harvest respectively followed by natural farming treatment and least enzyme activity was noticed in farmer's practice Fig 2 and Fig 3. Same trend was observed in acid and alkaline phosphatase enzyme activities Fig 4 and Fig 5. Enzymes play major role in biochemical functions in the overall process of decomposition of organic matter and release of available nutrients for easy uptake and utilization by the plants. These findings are in agreement with Ramesh et al. 2018¹⁷ and Kasbe et al. 2009⁶. In the

present study, natural and organic farming treatments showed enhanced dehydrogenase, urease, acid and alkaline phosphates activity. This might be due to a more significant number of microorganisms in jeevamrutha and ghanajeevamrutha inputs when these are applied to the soil which further multiplies in the soil and acts as a tonic to enhance the microbial activity in the soil. Lori et al. (2017)⁸ reported that three times more dehydrogenase activity was recorded in organic farming than in conventional farming. Similar results were also reported by Vinay et al. 2020¹⁶, where they noticed higher activity of these enzymes in organic farming followed by natural farming. This was evidenced by Boraiah et al. (2017)².

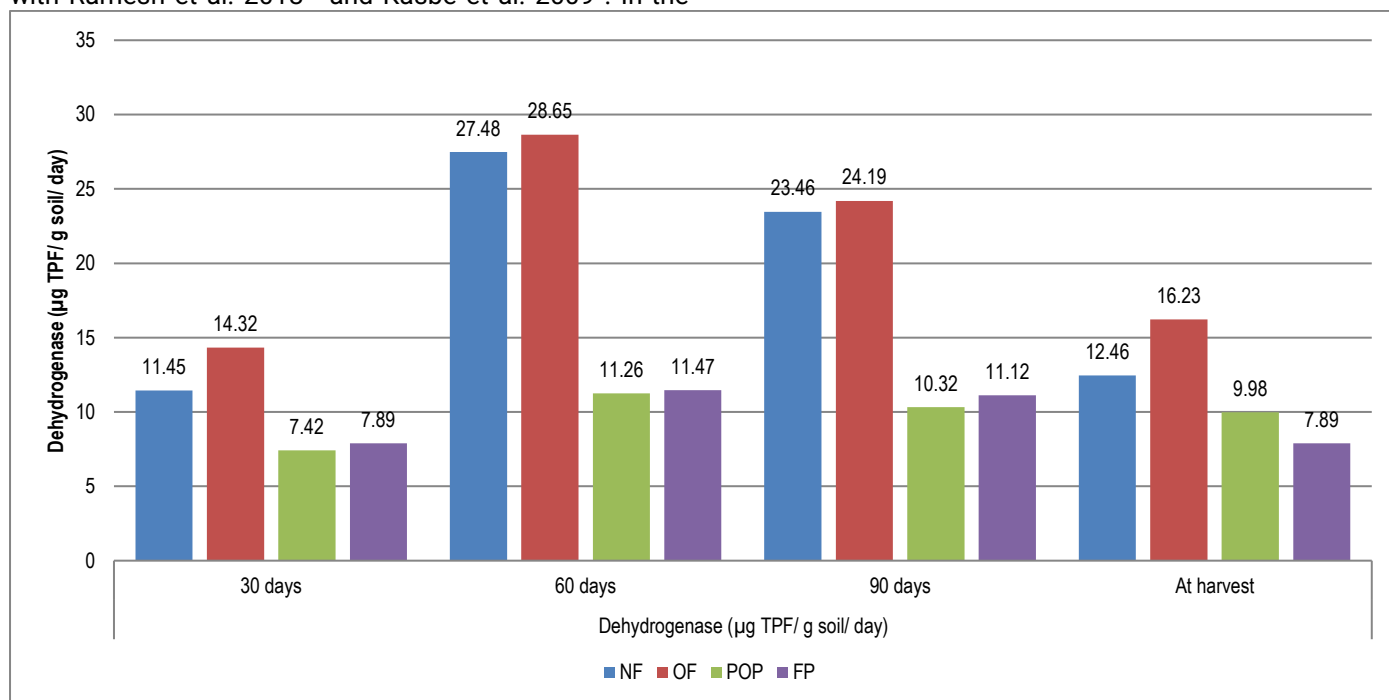


Figure 2. Dehydrogenase Enzyme activity in intercropping system of Maize + Red gram

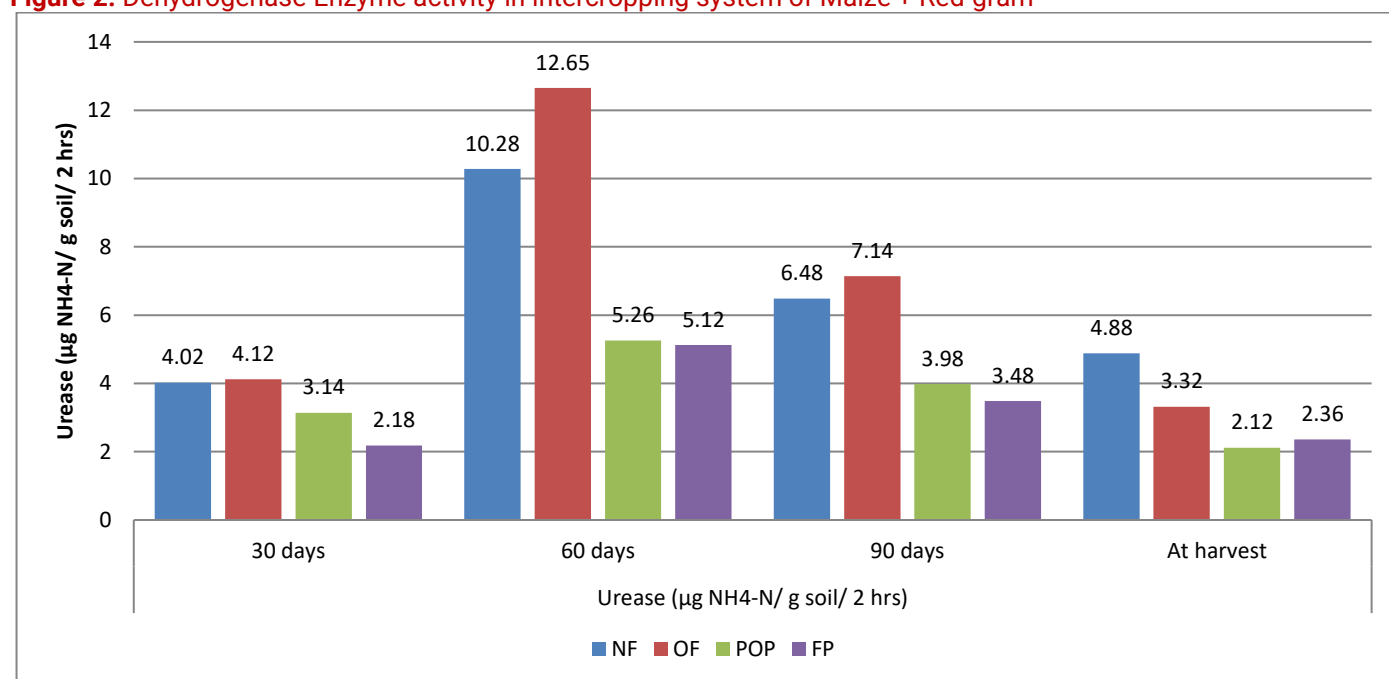


Figure 3. Urease Enzyme activity in intercropping system of Maize + Red gram

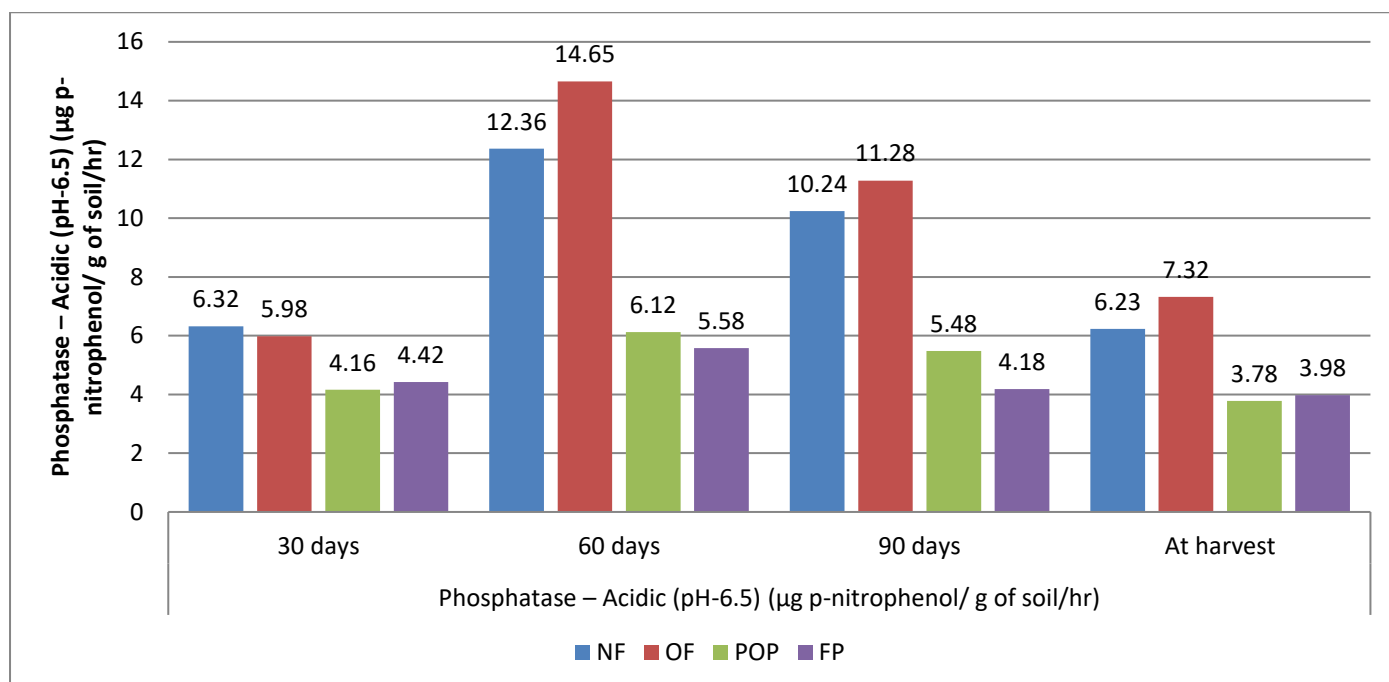


Figure 4. Phosphatase -Acidic Enzyme activity in intercropping system of Maize + Red gram

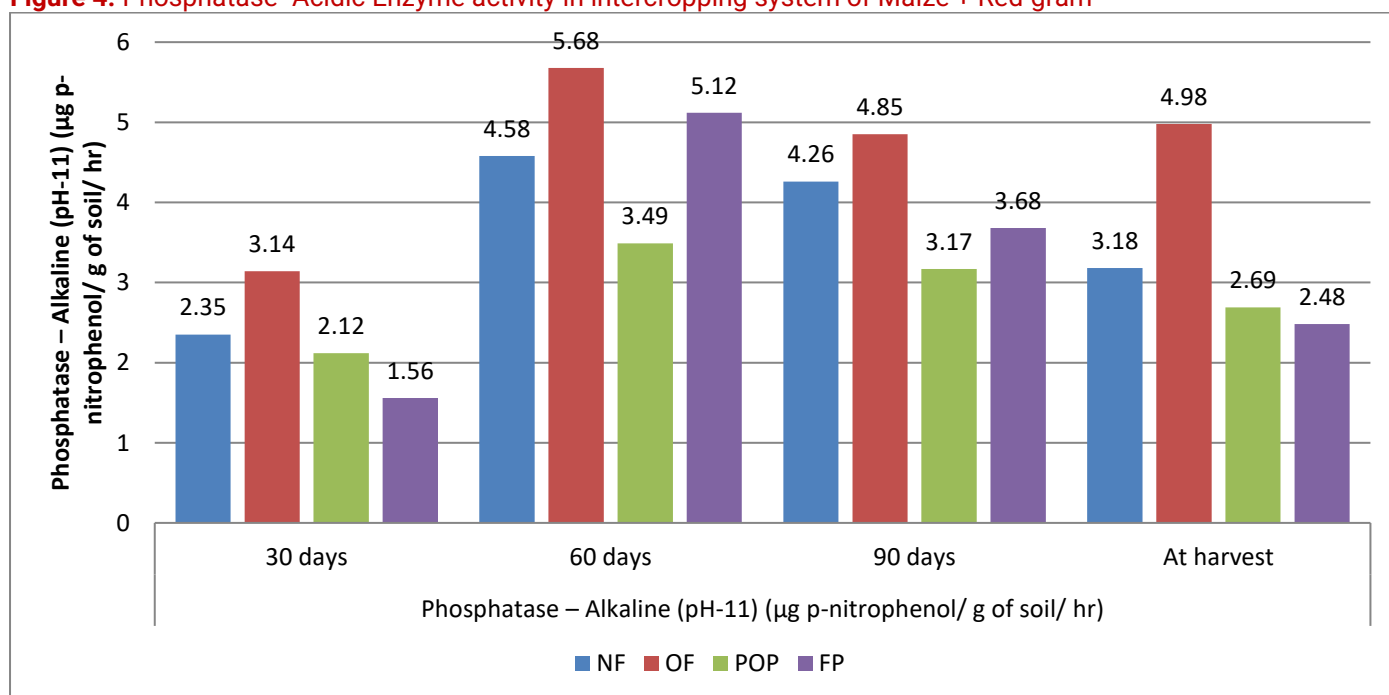


Figure 5. Phosphatase -Alkaline Enzyme activity in intercropping system of Maize + Red gram

Declaration of interests

The authors have no conflict of interest to declare.

Data Sharing

All relevant data are within the manuscript.

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