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Effect of Mulching and Different Doses of Phosphorous in Cowpea *(Vigna unguiculata L.)* Yield and Residual Soil Chemical Properties at Bhairahawa, Nepal

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Abstract A research was carried to identify the production performance of catch crop cowpea at subtropical climatic condition of Nepal (Rupandehi) during dry to wet season transition period April to July 2014 using 6 different treatments with 4 replications in Randomized Complete Block Design (RCBD). Significant result at 5% level of probability with moisture retention of 14.463% in case of mulching and 12.970% in case of no mulched was observed. Similarly highly significant (at 1% level of probability) result was found for plant height at 13 days after sowing with plant height of 17.498cm in case of mulching and 14.459cm in case of no mulching. The result shows highly significant result for effect of mulching in cowpea yield <at $p \leq 0.05$> yielding 5.706 ton/ha in mulched field and 4.215 ton/ha in no mulched field. Effect of mulching shows significant result at 5% level of probability in case of pod length. The length of pod recorded in mulched plot was found to be 43.651 cm and 39.531 cm in no mulched plot. Similarly, significant results (at $p \leq 0.05$) in interaction of both mulching and recommended doses of phosphorous shows maximum pod length recorded of 46.920 cm and minimum of 38.497 cm when control dose of phosphorous interacted with no mulching condition. Since organic matter formation and change in soil chemical properties is long and gradual period no significant results are found in soil chemical properties. Significant results of phosphorous solely are not achieved during this short research duration. Data from economic analysis revealed that Mulching leads to significant high yield as compared to non-mulching with B: C ratio calculated 1.58 and 0.99 respectively in mulched and no mulched condition. Cowpea yield shows significant difference between mulching and no mulching effect and was successfully harvested within the short period. So it is beneficial to crop cowpea with mulching to have better yield of cowpea and aid soil nutrients during dry to wet transition season in Rice-Wheat cropping systems of Nepal.

Keywords*: cowpea yield, mulching, phosphorous, catch crop, B: C ratio*

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1. Introduction

Grain legumes are the important crops in terms of their contribution to human nutrition. ASD [3] reported that the grain legumes cover 10.5% of the total cultivated land of Nepal. Grain legumes occupy 10.22% of the cultivated area which is equal to 0.316 million ha with 0.27 mt production and productivity of 0.85 t/ha [2]. Per capita consumption of grain legumes in Nepal is around 10kg/annum or 27g/capita/day [26] which is 3 times less than minimum requirement (80 g/ capita/day) prescribed by WHO [42].

Cowpea (Vigna unguiculata) is an important crop, contributing to the health and livelihood of millions of people in tropical and sub-tropical countries, particularly Africa (Nigeria, Niger, Burkina Faso, Ghana, Kenya, Uganda, Tanzania, Senegal, Togo) and Asia (India, Pakistan, Bangladesh, Sri Lanka, Burma, Thailand, Nepal, China, Malaysia) [32].

On average cowpea grains contain 23-25% protein and 50-67% starch in dry bases [37]. From a single planting, one may be able to have several products such as leaves, immature pods, immature and mature seeds. Careful and positive attention to cowpea would support 850 million people in the world with high incidence of undernourishment in sub-Saharan Africa as documented by FAO [11,12].

Cowpea is grown mostly in Terai region of Nepal. It is generally grown as intercrop in maize. The research in cowpea is very less in case of our country and farmer

generally plant cowpea just for the purpose of the vegetables. They rarely used the recommended doses of different fertilizers as cowpea is considered minor crop with next major crop. Despite being the grain legumes it is an important crop that fixes atmospheric nitrogen in the soil and helps to maintain the soil health and fertility and makes soil favorable for next season crops. Cowpea responds to applied phosphorus by which it increases its root growth, nodulation and growth yield [9]. Similarly, mulching had positive effects on soil moisture conservation and improved cowpea yield [18,33].

Soil is vital to life and thus called 'the greatest heritage of mankind'. Humans were historically dependent on hunting and gathering of food to sustain life. With the increase in human population, organized agricultural systems were needed to ensure food security. Our relationship with soil is based upon cultivation of soil throughout human history and led to success of civilizations. This relationship between humans, the earth and the food sources upholds the soil as the foundation of agriculture [29]. Soil is the integrated component of agriculture, forest and grassland ecosystems [4]. The ecosystem approach in the study of soil allows us to use an integrated approach in the management of the soil problems [15]. Mitigating soil problems results in healthy soil, improved supply of essential nutrients for plant growth, good soil environment and reduced environmental hazards.

Hence, to make the use of land which is being barren after the harvest of wheat and before plantation of rice here in case of Bhairahawa, Nepal and to prevent soil leaching and loss of nutrients by the activity of nodules this research attempts is made to see the feasibility and practical application of growing cowpea under two different factors; mulching and different doses of phosphorous.

Though Nepal has tremendous capacity for the production of cowpea there is lack of support for research on cowpea improvement with respect to manpower and operational Nepal Government funds. In addition there is little improved technology to extend inclusively improved seeds, lack of credits, production inputs and poor planning and inadequate management. Nepalese farmers are leaving land barren between two successive crops due to lack of knowledge about catch crops and short duration crops that have both economical and ecological importance. Cowpea is among various grain legumes that have short crop cycle bearing both economic and ecological importance. Similarly farmers are adopting improper cultivation practices of cowpea using different doses of fertilizers that are not recommended and cowpea is being considered crop of minor importance.

Likewise due to insufficient research works on the management of cowpea, different doses of phosphorous, effect of mulching and sowing times farmers are unable to exploit the potential yield of Cowpea under Bhairahawa condition and similar agro-climatic condition of Nepal.

The increase in productivity of cowpea will assist to fulfill the increasing demand of protein food. Careful and positive attention to cowpea would support 850 million people in the world with high incidence of undernourishment as documented by FAO [11,12].

Cowpea is a newly introduced crop in case of Nepal. Farmers are cultivating it without any information of accurate time of sowing and nutrient application. Sole cropping of cowpea is not usually being practiced by farmers as they prefer intercropping with maize. Knowledge about soil health and soil productivity in relation to yield and growth and benefit of planting legumes is still not in reach among many farmers. After field survey to know about biodiversity status of people residing around this Paklihawa, Bhairahawa we found that between the periods of wheat harvest to rice plantation they rarely cultivate in the field. This condition degrades the soil causing leaching and flow of soil nutrient. Temperature during summer ranges between 35-40°C, mulching plays great role in conserving soil moisture and gives crops suitable growing condition [10] this leads to good cultivation and production. Growing legume crops fixes atmospheric nitrogen and makes soil reach in nitrogen which is another major benefit. Mulching helps to add organic matter as well in long period.

As there is limited research in the field of cowpea and effect of mulching and phosphorous in this region, our experiment wants to disclose the feasibility of growing cowpea as catch crop under different treatments for both economical and ecological benefit for the farmers. So finding of this research work will help to increase the productivity of cowpea as well as livelihood status of the people involved in its cultivation. An attempt was made to find the feasibility of mulching and application of different doses of fertilizer to enrich the fertility status of soil.

2. Materials and Methods

2.1. Cropping History and Experimental Design

Experiment was conducted at Horticulture Farm of IAAS, Paklihawa Campus, Bhairahawa which was barren for past few months. Initial chemical properties of the research field reads as given in the table below.

Table 1. Chemical properties of soil in the research site (2014)

Soil parameter	Values	Rating
Organic Matter%	1.88	Low
Total N%	0.09	Low
P_2O_5 (kg/ha)	49.9	Medium
K_2O_5 (kg/ha)	130.4	Medium
pH	7.4	Neutral

Bhairahawa is a low land in plain area and dominantly prevails with alluvial clay soil. Soil of the experimental site was low in organic matter content & total available Nitrogen but Medium in exchangeable potassium and available soil Phosphorus with Neutral pH.

2.2 Experimental Setup

2.2.1. Field Layout

The experiment was laid out on Randomized Complete Block Design (RCBD) with 4 replications. First factor was different doses of Phosphorous (48, 40 and 32 Kg/ha), which was incorporated in the field prior to seed sowing and next factor was mulching (mulched and no mulched) which was done in selected plots after sowing of seed. Plant to plant spacing was maintained 20 cm and row to

row spacing was maintained 60 cm. The area of each plot was (1x1.5) 1.5 m^2 and spacing between plots in same replication was 20 cm. There were 24 plots and total area under cultivation was thus (24 x1.5) 36 m^2. Two adjoining replications were separated by distance of 1m. There was two row in each plots and 7 plants in each row.

2.2.2. Treatment Detail

The research consists of 3 levels of phosphorous and 2 types of mulching.

Recommended dose (20:40:20 Kg NPK/ha)
High dose of phosphorous: (20:48:20 Kg NPK/ha)
Control dose of phosphorous: (20:00:20 Kg NPK/ha)

All these doses are coupled with 20kg/ha of Farm Yard Manure.

So, there were all together 6 treatments.

Table 2. Treatment details used during research process

Treatment Number	Treatment Combination		Symbol
	Mulching	Phosphorous Dose	
T_1	Mulched	High	M_1P_H
T_2	Mulched	Recommended	M_1P_R
T_3	Mulched	Control	M_1P_C
T_4	No mulched	High	M_2P_H
T_5	No mulched	Recommended	M_2P_R
T_6	No mulched	Control	M_2P_C

M_1: Mulched and M_2: No mulched ; P_H: High dose, P_R: Recommended dose, P_C: Control dose.

2.2.3. Cultivation Practices Adopted

Two ploughing followed by harrowing was done manually to break down the clods, water channels were made around the field and the field for experiment was raised few centimeters than the normal level of the field. Cowpea (*Vigna unguiculata*) seeds were collected from Siddhartha Agrovet of Bhairahawa Market. Long Yard Bean (Pole type) was the variety used for the experiment. Two seeds per hill was sown with two rows and seven hills per row is a single plot 0f 1.5 m^2 area. Full dose of Nitrogen, Phosphorus and Potassium was applied after preparation of the field before sowing. Farm Yard Manure was also applied in the field at the rate of 20 Ton/ha in whole field. Immediately after sowing of the seed in the plot Mulching was done as per the treatment in respective plots. Mustard straw was used as a Mulching material. Mulching of 6 t/ha was maintained in the field. Mustard has a C:N ratio of 33:1. Mustard straw is easily available around those areas so it was selected for the research purpose Irrigation, weeding and hoeing were done at regular interval.

2.3. Soil and Plant Parameter Studied

2.3.1. Recording of Soil pH, Nitrogen, Phosphorous, Potassium and Organic Matter Content

Soil samples were collected in a Z-shape with 15 spots from each replication at a depth of 20 cm before application of FYM and fertilizers. A composite sample was made for each replication by mixing the soil of 15 spots of each replication. It was then be shade-dried, ground, sieved through 1.4 mm sieve and subjected to determine their major nutrient status of experimental site. Similarly, final soil sample was collected from each plots, total 24 samples were taken after harvesting. Their nutrient status was determined using following analysis method;

Table 3. Laboratory analysis technique used to analyze soil chemical properties

Parameters	Analysis methods
Soil pH	Beckman Glass Electrode pH meter [41]
Soil organic matter	Walkley and Black [40]
Soil total nitrogen	Kjeldahl distillation [6]
Soil available phosphorus	Olsen's bicarbonate [28]
Soil available Potassium	Ammonium acetate [5]

2.3.2. Phenological Observation of Cow pea

Six sample plants from each plot were selected randomly to determine various Phenological characters such as plant height, yield attributing characters and yields. The height was measured from the point near to soil surface to the longest portion of the plant tip. The following parameters were taken under consideration: Number of pods/plant, No of seeds/pod, length of the pods, number of seeds /pod, weight per/pod, weight of the seed/pod, Green pod yield (ton/ha) and dry weight of pods

2.4. Statistical Analysis

All the recorded data were compiled and analyzed through MSTAT-C package. Mean were separated by Least Significant Difference test (LSD) and Duncan's Multiple Range Test (DMRT).

2.5. Economic Analysis

Cost of cultivation was calculated on the basis of local rates of inputs used during the research, gross return was calculated from the value of grain yield/ha and the difference of gross return and cost of cultivation was the net return obtained then the Benefit: Cost ratio was calculated for the purpose of economic analysis.

2.6. Meteorological Data during Cropped Season

The experimental site lies in the sub-tropical humid climatic zone of Nepal. It is characterized by three distinct seasons: Rainy Monsoon, Cool Winter and Hot Spring. The meteorological data such as temperature (maximum, mean and minimum), and rainfall were recorded during cropping period from nearest point of agro meteorological data recorder, Bhairahawa Airport, Bhairahawa. Maximum temperature, mean temperature, minimum temperature and precipitation recorded during the period is recorded is show in the Figure below. Data reveals that maximum temperature recorded was 41°C and minimum temperature was 17°C with precipitation only for three times recording 8mm maximum and 4mm minimum.

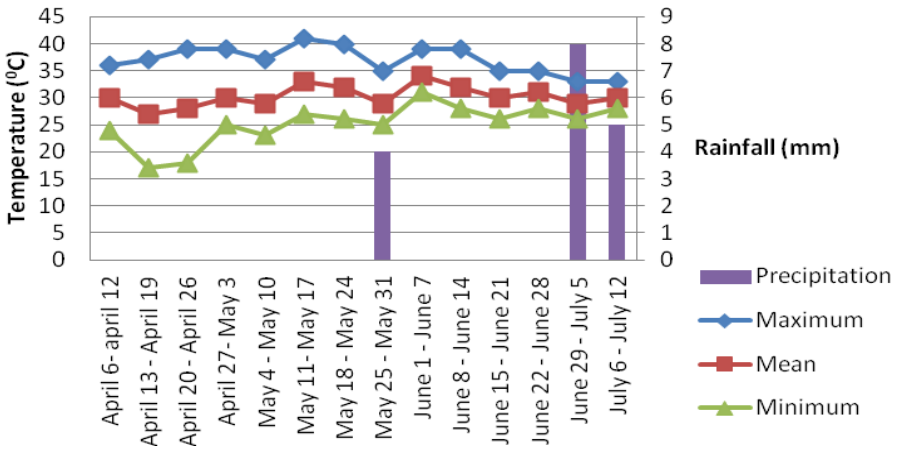

Figure 1. Weather of Experimental site during the experimental period (April-July, 2014)

3. Result and Discussion

3.1. Soil Moisture

3.1.1. Effect of Mulching in Soil Moisture

Moisture content of the soil varies significantly with the effect of the mulching. Mulching had positive effects on soil moisture conservation and improved cowpea yield [19,33]. Our field research shows significant result at 5% level of probability with moisture retention of 14.463% in case of mulching and 12.970% in case of no mulched. Tolk et al. [39] and Liu et al. [22] has concluded that mulching increases soil moisture and nutrients availability to plant roots, in turn, leading to higher grain yield.

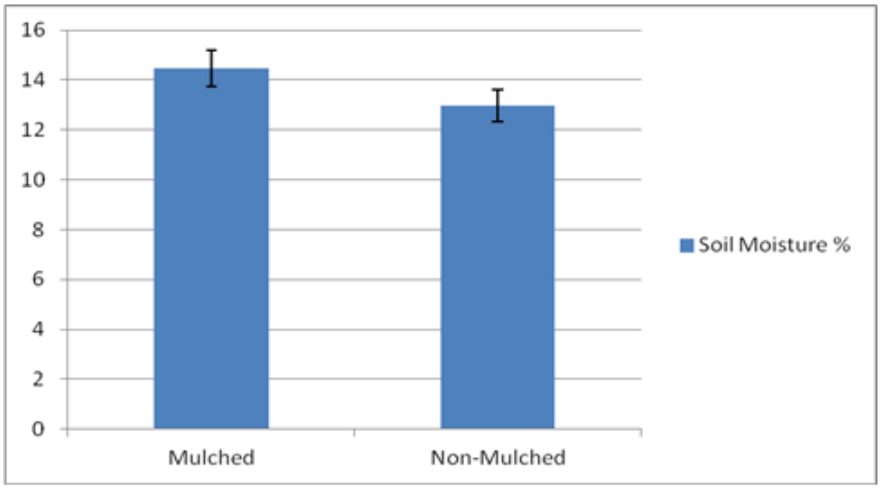

Figure 2. Effect of mulching in Soil Moisture Content

3.2. Plant Height

Table 4. Effect of mulching and different doses of phosphorous in cowpea plant height in Paklihawa, Bhairahawa, Nepal, 2014

Treatments	Plant height 13 DAS	Plant height 18 DAS	Plant height 23 DAS	Plant height 28 DAS
Mulching				
Mulched	17.498	25.407	32.975	47.048
No Mulched	14.459	23.461	29.726	42.919
Phosphorous Dose				
High	15.835	24.121	31.624	45.565
Recommended	15.707	23.644	30.180	42.184
Control	16.394	25.536	32.248	47.202
SEm	0.8566	1.485	2.159	4.982
LSD	2.582	4.475	6.507	15.02
CV%	10.72	12.15	13.77	22.15
Grand Mean	15.979	24.434	31.350	44.984
Probability factor A	0.0006 **	Ns	Ns	Ns
Probability factor B	Ns	Ns	Ns	Ns
Probability factor AB	Ns	0.0461*	0.0278*	0.0376*

* represent significant at 5% level of probability, ** represent significant at 1% level of probability, Ns represent no significant.

3.2.1. Effect of Mulching on Plant Height

13 DAS

Soil moisture plays crucial role during growth and vegetative stage. Result reveals that effect of mulching in regards to plant height is highly significant (at 1% level of probability) till 13 days after sowing with plant height of 17.498cm in case of mulching and 14.459cm in case of no mulching.

18 DAS

Result reveals that effect of mulching solely doesn't have any significant result in case of plant height. But revealed data suggested interaction of mulching and different doses of phosphorous have significant result at 5% level of probability with maximum height of 28.780 cm in mulching and control dose of phosphorous interaction and minimum height of 22.293 cm in no mulching and control dose of phosphorous interaction.

23 DAS

Mulching solely doesn't reveal any significant results but their interaction with different doses of phosphorous shows significant result at 5% level of probability. Maximum height was recorded to be 37.640 cm in mulching and control dose of phosphorous interaction and minimum height was recorded to be 26.855 cm in no mulching and control dose of phosphorous interaction.

28 DAS

With increase in days after showing, interaction of mulching and control dose of phosphorous recorded maximum plant height measuring 57.492 cm at 28 DAS and minimum in no mulching and control dose of phosphorous interaction with height of 36.912 cm. These interactions were found significant at 5% level of probability.

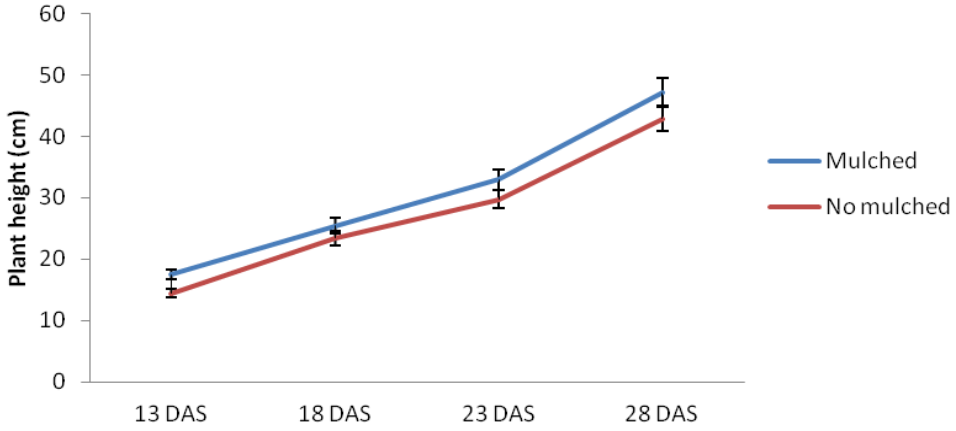

Figure 3. Effect of Mulching in plant height of cow pea with respect to days of sowing

3.2.2. Effect of Phosphorous in Plant height

Result obtained revealed no any significant result solely in response to different phosphorous doses. But the interaction of control dose of phosphorous with mulching has significant results at 5% level of probability with maximum plant height measuring 57.492 cm at 28 DAS and minimum in no mulching and control dose of phosphorous interaction with height of 36.912 cm.

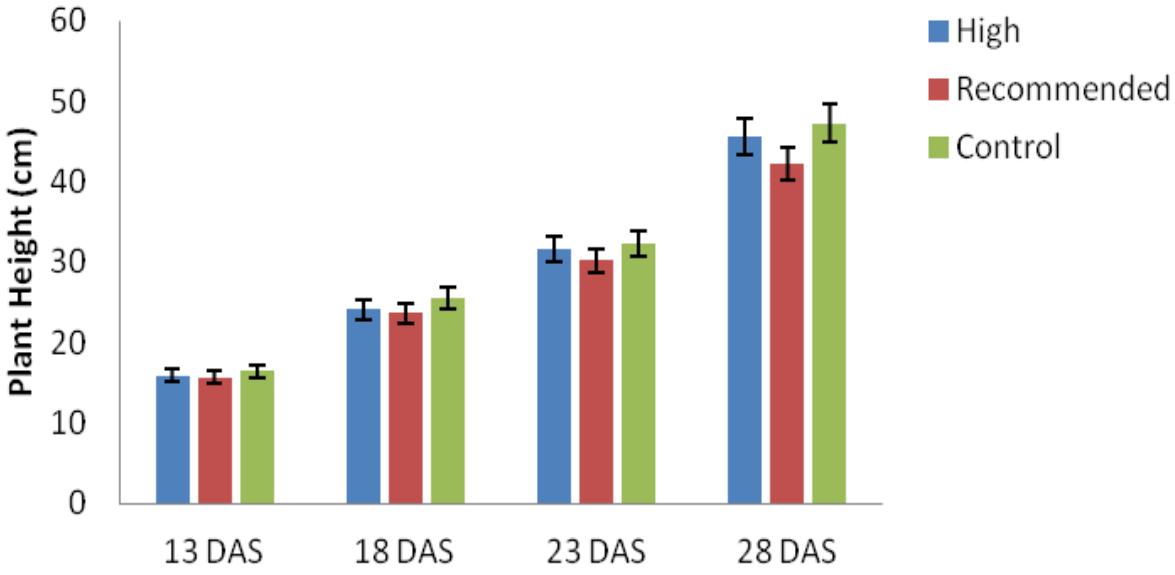

Figure 4. Effect of phosphorus in growth pattern of cowpea with respect to days of sowing

3.3. Soil Chemical Properties

Table 5. Effect of mulching and different doses of phosphorous in residual soil chemical properties in Paklihawa, Bhairahawa, Nepal, 2014

Treatments	Organic Matter (%)	Nitrogen (%)	Phosphorous (P_2O_5) (kg/ha)	Potash (K_2O) (Kg/ha)	pH
Mulching					
Mulched	2.113	0.106	147.117	219.992	7.600
No Mulched	2.066	0.104	159.675	154.208	7.617
Phosphorous Dose					
High	2.087	0.106	153.387	184.825	7.537
Recommended	2.170	0.107	161.637	184.837	7.637
Control	2.011	0.101	145.163	191.637	7.650
SEm	0.1688		11.82	19.16	0.1012
LSD	0.5089		35.62	57.75	0.3052
CV %	16.12	17.33	15.41	20.48	2.66
Grand Mean	2.090	0.105	153.396	187.100	7.608
Probability factor A	Ns	Ns	Ns	0.0008**	Ns
Probability factor B	Ns	Ns	Ns	Ns	Ns
Probability factor AB	Ns	Ns	Ns	Ns	Ns

Ns represent no significant. ** represent significant at 1% level of probability.

3.3.1. Effect of Mulching in Soil Chemical Properties

3.3.1.1. Effect of Mulching in Residual Organic Matter Content

No significant results were observed in organic matter content due to the use of mulching. As the research was of short term and increase in organic matter content is long and gradual process it is not likely to increase organic matter content in this short period. However, organic matter content of the soil was measured 2.113% in mulched soil and 2.066% in no mulched as shown in Figure 5. This data revealed that organic matter content is low [40].

3.3.1.2 Effect of Mulching in Residual Nitrogen Content of Soil

Effect of mulching in soil nitrogen content was found highly insignificant. However the nitrogen content in the field was recorded medium when measured with Kjeldahl distillation [6] recording 0.106% and 0.104% respectively in mulched and no mulched soil as show in Figure 5.

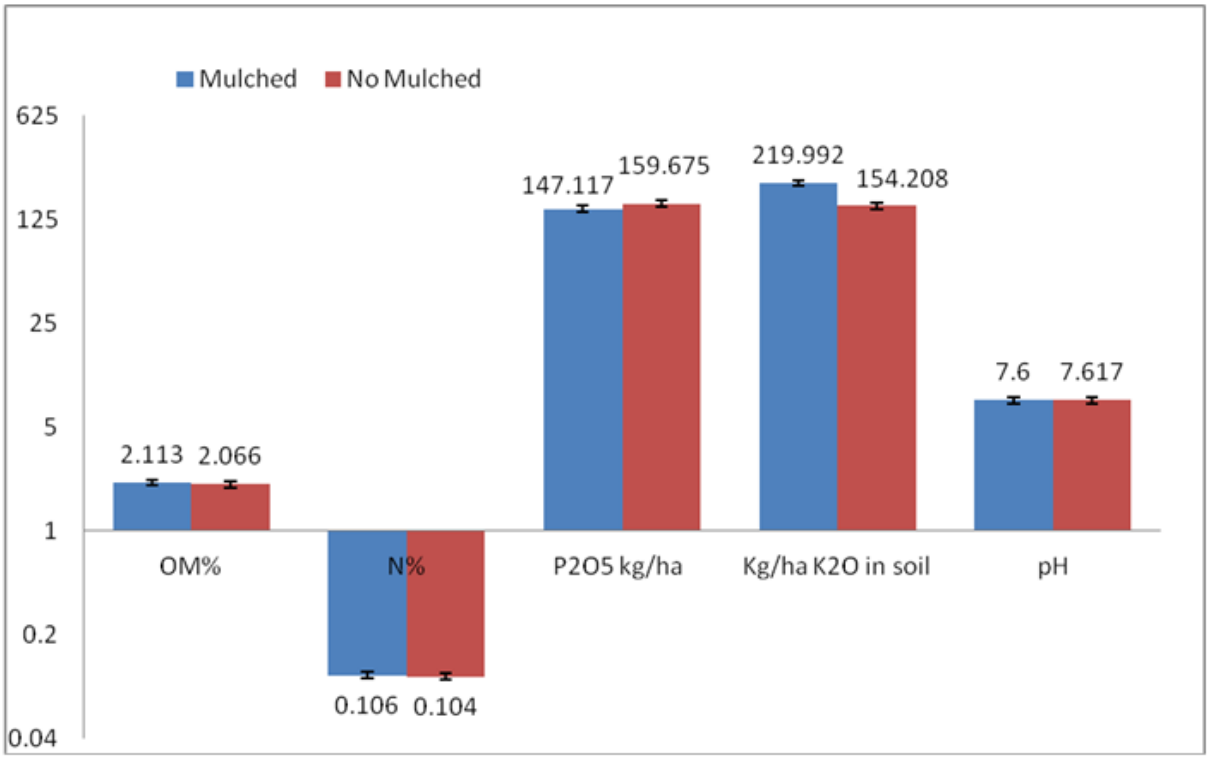

Figure 5. Effect of Mulching in different Soil Chemical Parameters

3.3.1.3. Effect of Mulching in Residual Phosphorous Content of Soil

Insignificant result was observed for the effect of mulching in phosphorous content of the soil. Soil samples tested after final harvest reveals that the phosphorous content was found 147.117 kg P_2O_5/ha in mulched soil

and 159.675 kg P_2O_5/ha in no mulched soil which is shown in Figure 5. Though the result is insignificant the phosphorous content of soil is satisfactory and is labeled as very high when measured through Olsen's bicarbonate.

3.3.1.4. Effect of Mulching in Residual Potash of the Soil

Highly significant result, as shown in Figure 5, was observed on the effect of mulching in potash content of the soil at (1 % level of probability) measuring 219.992 kg K_2O/ha in mulched soil and 154.208 kg K_2O/ha in no mulched soil.

3.3.1.5. Effect of Mulching in pH of the Soil

Soil pH was less likely affected by mulching and is found insignificant measuring 7.6 and 7.617 in mulched and no mulched soil which is clearly shown in Figure 5.

3.3.2. Effect of Different Doses of Phosphorous in Soil Chemical Properties

3.3.2.1. Effect of Different Doses of Phosphorous in Residual Organic Matter Content.

No significant results were observed in organic matter content due to the use of different doses of phosphorous. As the research was of short term and increase in organic matter content is long and gradual process it is not likely to increase organic matter content in this short period. However, organic matter content of the soil was measured 2.087%, 2.170% and 2.011% in high dose, recommended dose and control dose application of phosphorous which is shown in Figure 6.

3.3.2.2. Effect of Different Doses of Phosphorous in Residual Nitrogen of Soil

Effect of different doses of phosphorous in soil nitrogen content was found insignificant as shown in Figure 6. However the nitrogen content in the field was recorded medium when measured with Kjeldahl distillation [6] recording 0.106%, 0.107% and 0.101% when high, recommended and control dose of phosphorous are applied respectively. This result shows that high dose of phosphorous would not aid to increase nitrogen content of the soil.

3.3.2.3. Effect of Different Doses of Phosphorous in Residual Phosphorous of Soil

Insignificant result was observed for the effect of phosphorous in phosphorous content of the soil. Soil samples tested after final harvest reveals that the phosphorous content was found 153.387 kg P_2O_5/ha when high dose of phosphorous is applied, 161.637 kg P_2O_5/ha when recommended dose of phosphorous is applied and 145.163 kg P_2O_5/ha when control dose of phosphorous is applied and is shown in Figure 6. Though the result is insignificant the phosphorous content of soil is satisfactory and is labeled as very high when measured through Olsen's bicarbonate [28]. This result shows that application of more phosphorous than recommended would not aid to increase phosphorous content of the soil.

3.3.2.4. Effect of Different Doses of Phosphorous in Residual Potassium of the Soil

Effect of phosphorous shows no any significant results in potassium content of the soil but measures 184.825 kg K_2O/ha when high dose of phosphorous is applied, 184.837 kg K_2O/ha when recommended dose of phosphorous is applied and 191.637 kg K_2O/ha when control dose of phosphorous is applied.

3.3.2.5. Effect of Different Doses of Phosphorous in pH of Soil

Soil pH was less likely affected by application of different doses of phosphorous and is found insignificant, as shown in Figure 6, measuring 7.537, 7.637 and 7.650 when high, recommended and control dose of phosphorous are applied respectively.

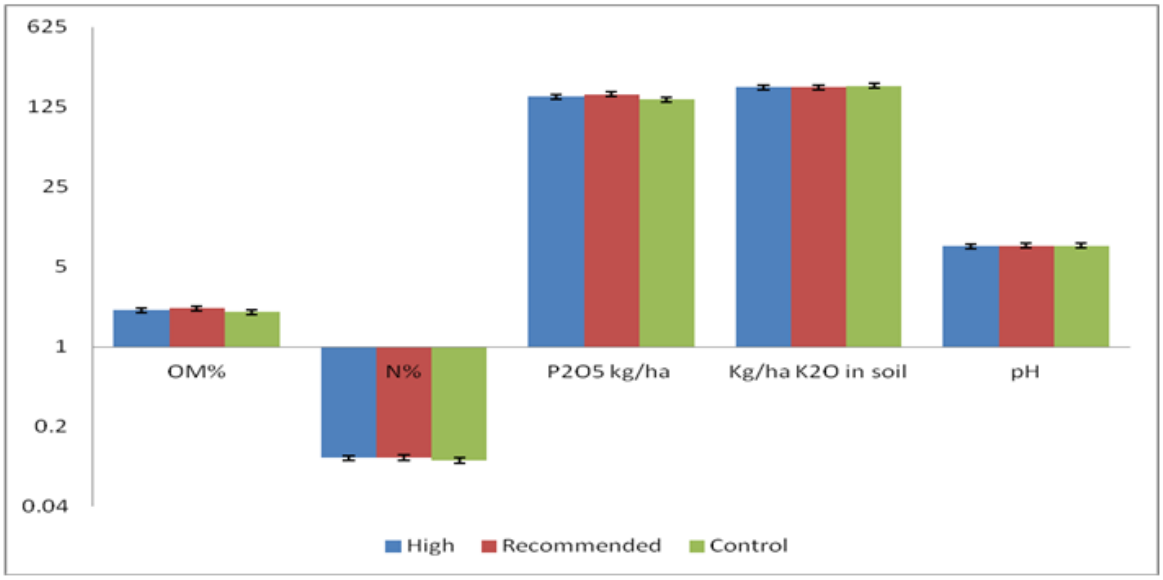

Figure 6. Effect of Different doses of Phosphorous in different soil chemical parameters

3.4. Effect on Biological Parameters

Table 6. Effect of mulching and different doses of phosphorous in cowpea biological parameters in Paklihawa, Bhairahawa, Nepal, 2014

Treatments	No. of Pod/plot	Pod Length	Green pod Wt.	Total Pod Yield
Mulching				
Mulched	76.750	43.651	855.908	5.706
No Mulched	69.000	39.531	632.277	4.215
Phosphorous Dose				
High	82.625	40.264	823.500	5.490
Recommended	58.375	42.920	585.810	3.905
Control	77.625	41.589	822.967	5.486
SEm	9.753	1.787	116.6	0.7772
LSD	29.40	5.388	351.4	2.343
CV%	26.77	8.60	31.33	31.33
Grand Mean	72.875	41.591	744.092	4.961
Probability factor A	Ns	0.0129*	0.0329*	0.0329*
Probability factor B	Ns	Ns	Ns	Ns
Probability factor AB	Ns	0.0340*	Ns	Ns

* represent significant result at 5% level of probability and Ns represent Not significant.

3.4.1. Effect of Mulching in Biological Parameters

3.4.1.1. Effect of Mulching in Number of Pods/Plot

Insignificant result was obtained for the effect of mulching in number of pods. However, the average length of 76.750 cm and 69.000 cm are recorded for mulched and no mulched plot respectively and is shown in Figure 7.

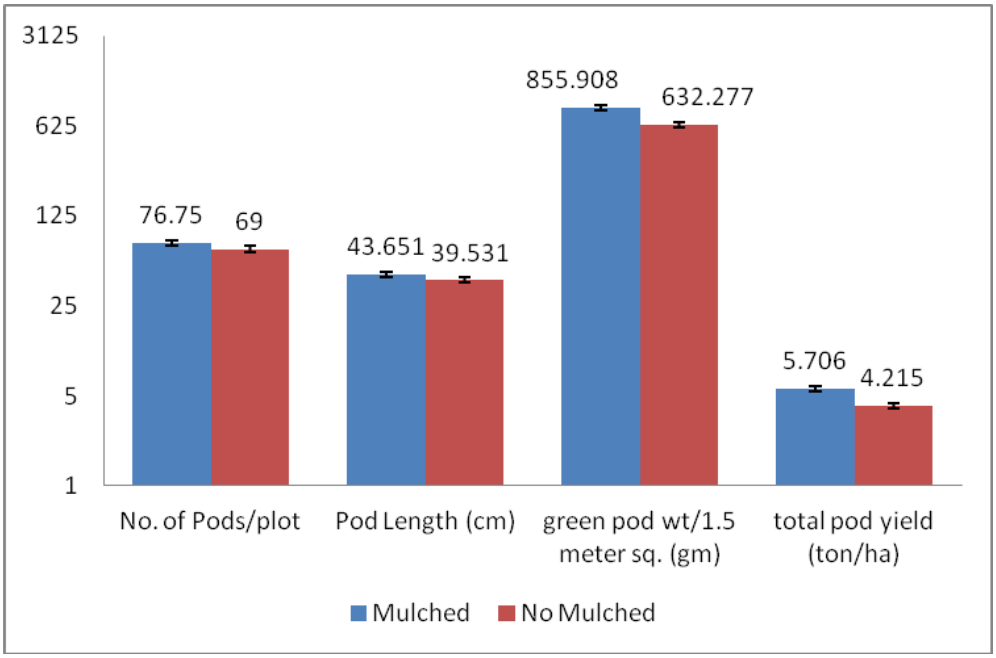

Figure 7. Effect of Mulching in biological parameters

3.4.1.2. Effect of Mulching in Pod Length

Effect of mulching and interaction of mulching and different doses of phosphorous shows significant result at 5% level of probability in case of pod length. The length of pod recorded in mulched plot was found to be 43.651 cm and 39.531 cm in no mulched plot. Similarly, maximum length of 46.920 cm was recorded when mulching and recommended dose of phosphorous interacted and minimum of 38.497 cm when control dose of phosphorous interacted with no mulching condition.

3.4.1.3. Effect of Mulching in Green Pod Weight/Plot

Green pod weight is found insignificant to the effect of mulching however the green pod yield of 855.908 gm/plot of 1.5 m^2 and 632.277 gm/plot of 1.5 m^2 were recorded in mulched and no mulched condition.

3.4.1.4. Effect of Mulching in Total Pod Yield

Mulching shows significant result in total pod yield of cowpea recording 5.706 ton/ha in mulched field and 4.215 ton/ha in no mulched field. Simpson and Gumbs [33] reported that mulched plots gave higher seed yield than

that of unmulched plots. Mulching had positive effects on soil moisture conservation and improved cowpea yield. [18,33]. This aids to our research finding as our finding is being similar to previous research activities.

Similar findings was recorded by B.K Singh 2014 suggesting Mulching of French bean with dried grasses and crop residues led to higher single pod weight, pod length, pod weight/ plant and pod yield by 10.9, 12.8, 20.1 and 20.2 %, respectively.

3.4.2. Effect of Different Doses of Phosphorous in Biological Parameters

Different doses of phosphorous shows insignificant result to number of pod/plot, pod length, green pod weight and total pod yield. However its interaction with mulching shows significant result for pod length. Interaction of both mulching and different doses of phosphorous shows maximum height recorded of 46.920 cm when mulching and recommended dose of phosphorous interacted and minimum of 38.497 cm when control dose of phosphorous interacted with no mulching condition. Abdel-ati [1] reported that phosphorus application had a significant effect on pod length of cowpea this showcase our finding on pod length is similar to previous research activities.

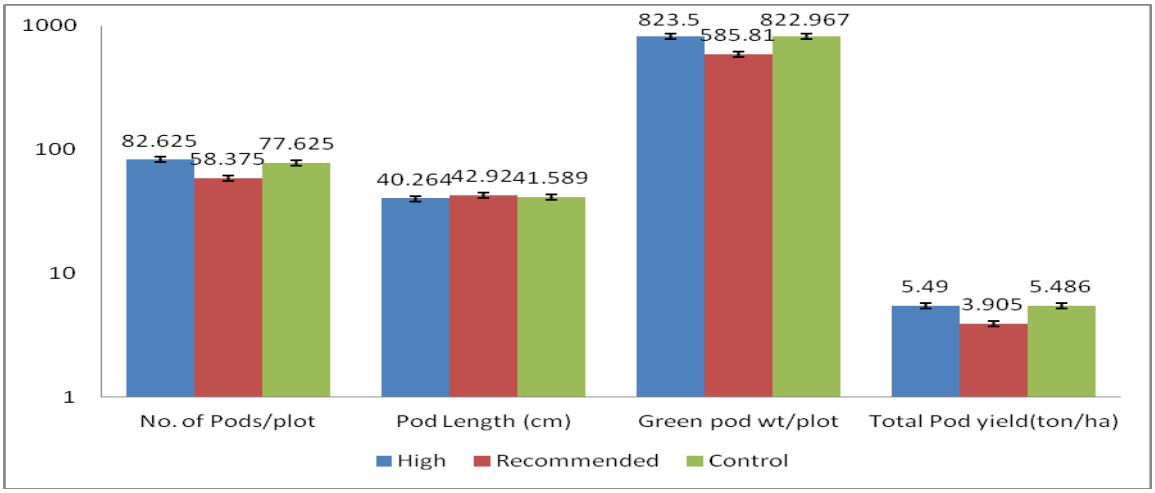

Figure 8. Effect of different doses of phosphorous in biological parameters

3.5. Economic Analysis

Data from economic analysis revealed that Mulching leads to significant high yield as compared to non-mulching and was economic method of cultivation of cowpea.

The then Labor cost was NRs.25/hr and selling price of Cowpea was NRs. 25/Kg. Based on these rates and the then market prices of other inputs used following economic calculation was made.

Table 7. Economic Analysis of Cowpea Cultivation in Paklihawa, Rupandehi, Nepal, 2014

Treatment	Cost (NRs/ha)	Return(NRs/ha)	Net Return(NRs/ha)	B:C
Mulching				
Mulched	1,44,140.00	2,28,240.00	84,100.00	1.58
Non-Mulched	1,69,147.00	1,68,600.00	-547	0.99

Both net return and B: C ratio was higher from Mulched plot as compared to unmulched plot. The average cost of cultivation was 17.34% lower from Mulched plot as compared to Non Mulching.

4. Summary & Conclusion

4.1. Summary

Field experiment was conducted to know the effect of mulching and different doses of fertilizer in cowpea yield and residual soil chemical properties in IAAS, Paklihawa Campus, Bhairahawa. There were 24 plots each measuring 1x1.5 m^2 with four replications and six different treatments. The whole experiment was designed in Randomized Complete Block Design (RCBD). In about 80 days, the whole field work, starting from land preparation to harvesting and final soil sample collection was finished. There were 14 plants in each plot of 1.5m^2 divided in two rows containing 7 plants in each row. Different biological parameters like, pod length, pod weight, number of pods/plant, green pod weight and total pod yield was recorded. Likely, soil chemical parameters like Nitrogen, Phosphorous, Potassium and organic matter content of the soil and soil pH were analyzed using appropriate methods. Data on soil moisture and plant height were also recorded. The data thus obtained were analyzed using MSTAT-C and bar/line graphs were designed using Microsoft Excel.

Soil moisture was affected by mulching showing significant result at 5% level of probability with moisture retention of 14.463% in case of mulching and 12.970% in case of no mulched.

Likely mulching showed highly significant role during germination and vegetative growth stage recording plant height of 17.498cm in case of mulching and 14.459cm in case of no mulching when measured in 13 DAS. 13 DAS significant effect of interaction of mulching and different doses of phosphorous was seen. Interaction of mulching with control dose of phosphorous recorded higher plant

height whereas lower plant height was seen in the interaction of no mulching and control dose of phosphorous. There were no any significant results solely by different doses of phosphorous to cowpea plant height.

Increase in soil organic content is a lifelong process which will take many years to increase its content. As our research was carried for short period, we were not able to see significant result of mulching and different doses of phosphorous application to soil chemical parameters. Significant result was observed in soil potassium due to effect of mulching measuring 219.992 kg K_2O/ha in mulched soil and 154.208 kg K_2O/ha in no mulched soil. Besides this, mulching has no any significant result to soil organic matter, nitrogen, phosphorous and pH. Similarly, no any significant results were there for the effect of phosphorous in soil parameters like organic matter, nitrogen, phosphorous, potassium and pH.

Mulching showed no any significant result to number of pod/plot and green pod weight but was significant to pod length and total pod yield. The length of pod recorded in mulched plot was found to be 43.651 cm and 39.531 cm in no mulched plot which was significant at 5% level of probability in case of pod length. Similarly, mulching revealed significant result in total pod yield of cowpea recording 5.706 ton/ha in mulched field and 4.215 ton/ha in no mulched field.

Effect of phosphorous has no any significant result in regards to organic matter content, nitrogen, phosphorous, potassium and pH of the soil. However, the interaction of phosphorous and mulching shows significant results for pod length with maximum height recorded of 46.920 cm when mulching and recommended dose of phosphorous interacted and minimum of 38.497 cm when control dose of phosphorous interacted with no mulching condition.

4.2. Conclusion

Soil moisture, plant height, pod length, total yield and potassium content were significantly affected by mulching. Interaction of mulching with different doses of phosphorous also showed significant results for plant height and pod length. Soil parameters, like organic matter content, nitrogen, phosphorous, potassium and pH to show significant results required long duration research period. Mulching also addresses on going conservation practices for sustainable and profitable farming. As cowpea yield are increased through the use of mulching we could suggest farmers to adopt mulching practices for profitable farming through sustainability. Though effect of phosphorous didn't showed any significant result but it was clear that there were no decrease in soil parameters content than that was in initial sample. It is also a great help to preserve soil nutrient. As farmers usually leave the land barren after wheat harvesting to before rice plantation, the short period between that could be best utilized through to preserve soil nutrient loss because of leaching and sun burn through the use of cowpea as catch crop.

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