



## Variation of Bio-phisco and edaphic parameters under organic mulch grown with French bean (*Phaseolus vulgaris* L.)

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### ABSTRACT

A field investigation was undertaken at the experiment farm of College of Postgraduate Studies in Agricultural Sciences, Umiam, CAU-Imphal, during winter season of 2015-16, to investigate the influence of organic mulches on bio-physical soil properties with french bean as a trial crop. The experiment was laid out in a split plot design with two organic mulches under main treatment and four French bean varieties under sub-plot. The initial values of soil pH was 4.83, organic carbon (1.95%), available NPK was 452.54, 15.35 and 220.08 kg ha<sup>-1</sup>, respectively; with a soil microbial bacterial count of  $8.7 \times 10^6$  (colony-forming unit) CFU mL<sup>-1</sup>. After the crop harvest it was found that there was a marginal increase in soil pH to 5.23, organic carbon (2.37%), available NPK is 598.96, 23.08 356.95 kg ha<sup>-1</sup>, respectively, and the bacteria count was  $11.2 \times 10^8$  CFU mL<sup>-1</sup> under weed mulching. During crop growing season, weed mulch provide a minimal variation in the soil temperature as compared to the maize stover mulch and the un-mulched which may have proved conducive for the growth of the soil bacteria. First decomposition of the weed mulch used which harbour more number of the micro-organisms in the soil. Selection-9 variety performed better (2.52 t ha<sup>-1</sup>) over rest three varieties under weed mulch treatment.

### 1. Introduction

French bean (*Phaseolus vulgaris* L.) is one of the major foods in Africa, India, and Latin America. A major leguminous crop providing a good source of protein in diet, serving as cash crop and becoming popular among the farmers of India. It contains about 17.5-28.7% protein in the dry seeds, 3.2-5.0% mineral matter, 4.2-6.3% crude fibre, 1.2-2.0% crude fat and 340-450 kcal energy (Arenas *et al.*, 2013). It grows well under regulated soil moisture, hence, mulching practice during non-rainy season is found to be a better option for growing this crop. Mulching avoids the fluctuations in temperature in the first 20-30 cm depth in soils. This promotes better root development and conducive soil

temperature in the planting bed, promoting faster crop development and earlier harvest. Mulching practice was found to yield greater total uptake of nitrogen, phosphorus and potassium as compared to un-mulched ones (Muhammad *et al.*, 2009; Marwein, 2016; Marwein *et al.*, 2017). Kumar *et al.*, 2014 found higher number of bacterial colonies in treated plots mulched with pine needle followed by those plots mulched with silver oak leaf as compared to other treatments. The benefit of organic mulching reported by many researchers (Somasundaram *et al.*, 2000; Sutagundi, 2000; Panda *et al.*, 2003; Kumar *et al.*, 2006; Choudhary and Bhamri, 2012; Gaire *et al.*, 2013; Inusah *et al.*, 2013; Parmar *et al.*, 2013, 2014; Sarma *et al.*, 2014; Singh *et al.*, 2014 and Tegen *et al.*, 2016; Mawthoh *et al.*, 2019; Dhivya and Ray,

2020). Tao *et al.*, 2015 found that 50% chopped straw mulching led to increased soil water content, and water use efficiency as well as lower water consumption than whole straw mulching. Yield in both the year was increased by 0.23 and 0.38 t ha<sup>-1</sup> in 2012 and 2013, respectively.

## 2. Material and Methods

A field trial was carried out during winter season of 2015 at the experimental farm of the College of Postgraduate Studies in Agricultural Sciences, Umiam, located at Ri-Bhoi district, Meghalaya, India to study the influence of soil temperature, soil bacterial count on soil nutrient and yield of French bean varieties. The experiment treatments were arranged in split plot design with three replications. The mulching practices, viz., weed mulch, maize and without mulch constituted main plot treatment and French bean varieties, viz., Selection 9, Anupama, HUR-15 and HUR-37 constituted sub-plot treatment. The experimental soil was sandy clay loam with PH of 4.83; organic carbon (1.95%), available NPK is 452.54, 15.35 and 220.08 kg ha<sup>-1</sup>, respectively. The bacterial count before sowing of the test crop was found out to be (8.7 × 10<sup>6</sup> CFU mL<sup>-1</sup>). The mulched material taken were chopped then spread uniformly in the treatment plot.

## 3. Results and Discussion

**Influence of organic mulching on soil temperature** There was a variation of soil temperature recorded during the crop growing period at 5 cm and 15 cm of soil depth. The afternoon soil temperature was found to be more as compared to the morning soil temperature in un-mulch treated plot at two depths. There is a rapid decrease in the soil temperature after 45 days of crop growing period; it may be due to the decrease of the atmospheric temperature toward the later part

of mid November month, similar pattern of observations was reported by Shaikh and Fouda, 2008. The soil temperature during daytime (from sunrise to sunset) decreased with increasing depth, while soil temperature increased with increasing depth at night. It was reported that the organic mulch was better than plastic mulching in hot climate due to its ability to reduce soil temperature.

Least variation in soil temperature was recorded for weed mulch with average maximum temperature 27-29.5°C, however, for maize stover mulch the range was between 23.5-26°C during the growing period, when the air temperature was the highest. Lamont, 2005; Yordanova and Gerasimova, 2015 also reported similar trends in soil temperature for straw mulch (organic mulch) where the variation in temperature was recorded to be the lowest. Effect of organic mulching on soil bacteria Soil bacterial colony count was found to be similar between the weed mulched and un-mulched treatment, whereas in maize stover mulched the bacterial population was found to be the lowest (Table 1). This may be due to the resistance of maize stover to decomposition, as compared to un-mulched and weed mulch residue treatment conditions. Soil biota increases under mulch conditions, which is conducive for a better soil environment. With an increase in soil biota colony there is an improving nutrient cycling of N and P through the micro fauna, biological nitrogen fixation and organic matter build up over a period of several years. The results were in well agreements with the findings given by Surya *et al.*, 2000; Brown *et al.*, 2001; Forge *et al.*, 2003; Holland, 2004. Higher number of bacterial colonies, fungal population and actinomycetes colonies in plots under mulched organic material were recorded as compared to other treatments (Sugiyarto *et al.*, 2009; Kumar *et al.*, 2014). Organic mulching technology support diversity of beneficial soil macro invertebrates, promoted soil quality, microbial biomass (Yang *et al.*, 2003; Birkhofer *et al.*, 2008).

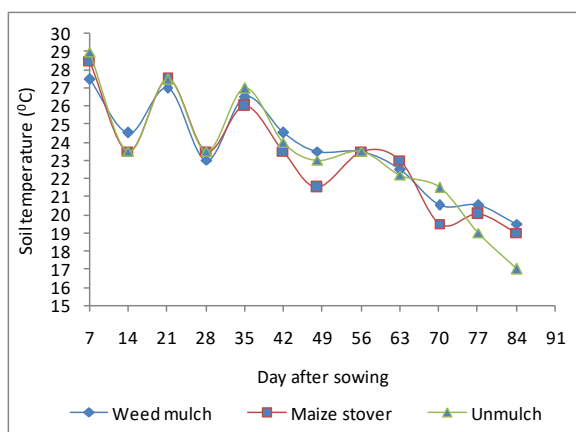


Fig. 1: Soil temperature at top 5 cm depth

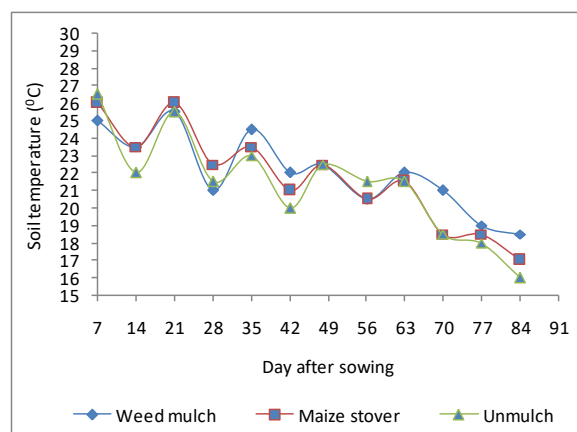


Fig. 2: Soil temperature at top 15 cm depth

Table 1. Bacterial count on the organic mulching

Treatments	Number of bacterial count (CFU/g) OD soil	Log CFU/g OD soil
Main plot (Level of Mulching = 03)		
Un-mulch (M0)	8.32 × 10 <sup>8</sup>	8.92
Maize stover mulch (M1)	6.31 × 10 <sup>8</sup>	6.80
Weed mulch (M2)	11.2 × 10 <sup>8</sup>	9.05
S.E.(m) ±		0.02
C.D.(P=0.05)		0.06
Sub-plot (Level of variety = 04)		
Anupama (V1)	1.66 × 10 <sup>8</sup>	8.22
Selection - 9 (V2)	1.55 × 10 <sup>8</sup>	8.19
HUR -15 (V3)	1.20 × 10 <sup>8</sup>	8.30
HUR -137 (V4)	1.20 × 10 <sup>8</sup>	8.30
S.E.(m) ±		0.02
C.D(p = 0.05)		0.05

### ***Effect of organic mulching on soil nutrient status***

Soil physico-chemical parameters were estimated before and after the growing period. The soil pH value as recorded before the trial was 4.83, however, under weed mulch treated plot there was a significant increase in soil pH (5.23) which is a positive soil indicator. Similarly the organic carbon content before the agronomic trial was 1.95 and later under organic mulching treated plot there was an increase in organic carbon content under weed mulch (Table 2). Similar results were also reported by Bajorienė *et al.*, 2013; Aragues *et al.*, 2014. Mulched treatments showed significantly greater total uptake of nitrogen, phosphorus and potassium than the corresponding un-mulched ones (Forge *et al.*, 2003; Saroa and Lal, 2004; Muhammad *et al.*, 2009). Improvement was due to the increase of

organic carbon and total nitrogen status of soil.

### ***Effect of organic mulching and varietal treatments on yield attributes of french bean***

There was no-significant results by the organic mulching treatments on the number of pods per plant, pods length, Seeds per pod, and Seed index (Table 3) where, un-mulched treatment recorded the lowest as compared to the mulch treatments. This may due to less availability of soil moisture which leads to poor fruit setting. The reductions in number of pods per plant may also be attributed due to abscission of flowers and pods (Malik *et al.*, 2006) or by the failure of fertilization due to the production of unviable pollens under moisture stress conditions under un-mulched plots (Ahmed and Suliman, 2010). And this might be due to the availability of soil moisture in the mulch plot which increases cell

Table 2. Soil nutrient status after crop season

Treatments	Soil nutrient status at upper layer				
	Soil pH	Organic Carbon (%)	Available N (kg ha-1)	Available P (kg ha-1)	Available K (kg ha-1)
Main plot (Level of Mulching = 03)					
Un-mulch (M0)	4.26	2.23	544.62	15.37	300.40
Maize stover mulch (M1)	4.98	1.92	546.93	17.18	271.89
Weed mulch (M2)	5.23	2.37	598.96	23.08	356.95
S.E.(m) ±	0.46	0.06	21.30	0.69	2.66
C.D.(P=0.05)	NS	0.24	NS	2.72	10.42
Sub-plot (Level of variety = 04)					
Anupama (V1)	4.55	2.22	570.01	17.79	308.98
Selection-9 (V2)	4.48	2.11	542.18	17.17	305.19
HUR-15 (V3)	5.13	2.13	574.56	20.75	314.58
HUR-137 (V4)	5.14	2.22	567.26	18.46	310.24
S.E.(m) ±	0.33	0.04	16.85	0.70	2.15
C.D(p = 0.05)	NS	NS	NS	2.08	6.40

Table 3. Yield Attributes of the French bean under Organic Mulching

Treatments	Pods per plant	Pod length	Seeds per pod	Seeds weight per plant	Seed index	Economic yield	Biological yield (t ha-1)	Harvest Index (%)
<b>Main plot</b>								
Un-mulch (M0)	16.21	12.36	5.72	24.09	34.87	2.05	6.23	32.91
Maize stover mulch (M1)	17.59	12.55	5.75	24.17	33.01	2.22	5.72	38.74
Weed mulch (M2)	17.88	12.64	5.74	25.92	34.72	2.37	5.67	41.09
S.E.(m) ±	0.60	0.44	0.07	0.34	1.714	0.06	0.28	0.79
C.D.(p = 0.05)	NS	NS	NS	1.35	NS	0.23	1.11	3.09
<b>Sub-plot</b>								
Anupama (V1)	22.18	11.74	6.51	26.45	30.54	2.17	6.01	36.11
Selection - 9 (V2)	20.11	15.05	6.48	29.59	34.54	2.52	6.34	39.62
HUR -15 (V3)	12.43	11.11	4.93	18.86	31.66	1.93	5.35	38.95
HUR -137 (V4)	14.18	12.16	5.02	24.01	39.81	2.23	5.79	38.95
S.E.(m) ±	0.73	0.45	0.10	0.57	1.04	0.08	0.17	1.17
C.D.(p = 0.05)	2.15	1.33	0.28	1.68	3.09	0.24	0.50	NS

expansion. Because of turgor pressure and increases of photosynthesis rate, which in turn, increases assimilate production and transportation from source to sink thereby increasing pod length (Al-Suhaibani, 2009).

Whereas significant result was recorded on the weight of seeds per plant, economic yield, biological yield and the harvest index (Table 3) this was mainly due to availability of optimum soil moisture content maintained at all stages of crop growth, which enabled higher nutrient uptake, greater dry matter accumulation, higher number of pods per plant, more grains per pod and increased hundred seed weight. Better control of weeds under mulch which could have also favoured to increase the yield as reported by Barman *et al.*, 2005; Chawla, 2006; Chinnathurai *et al.*, 2012. Earl and Davis, 2003 stated that a brief period of water deficit around silking time would prevent ovary fertilization, resulting in a reduced harvest index for maize crop. The results obtained for the mulching treatments may be interpreted as a ratio of economic to biological yield. With higher economic yield the values of HI increase and vice-versa. The recorded economic yield was found more for weed mulch as compared to the other. The biological yield was found to be more under un-mulched treatment.

In case of the French bean varieties significant result were recorded, where Selection-9 registered the highest pod length. Increasing the length of pod may be related with the age of the plant and its genetic characters as reported by Singh *et al.*, 1994; Rashid and Hossain, 2014; Marwein and Ray, 2019. This can be due to the genotype of the respective variety, as with relatively bolder seeds, with more number of seeds per pod, and higher bearing capacity per plant generally gives higher seed yield. Similar results were also reported by Zamir *et al.*, 2013; Das *et al.*, 2014; Tao *et al.*, 2015; Dhivya *et al.*, 2020.

Significant result was also recorded due to french bean varieties for the biological yield, where the lowest was registered by HUR-15 (Table 3) and highest was Selection-9 (6.36 t ha-1). This might due to the traits of French bean the number of seeds per pod, number of pods per plant. With relatively bolder seeds, with more number of seeds per pod the significant difference was observed among the French bean varieties. The results were in well agreement with the findings of Ulukan *et al.*, 2003; Abdollahi *et al.*, 2009; Golparvar, 2011; Marwein and Ray, 2019; Dhivya and Ray, 2020. In case of varieties lowest HI was recorded in HUR-15 (Table 3). The decline in the seed yield could occur due to a decrease in the production of pods and the number of seeds per pods and may be due to the traits of the variety. The results were well in agreement with the findings of Michałek and Borowski, 2006; Henry *et al.*, 2010; Dhivya and Ray, 2020; Dhivya *et al.*, 2020.

#### 4. Conclusions

From the field studies it was found there was a marginal increase in the soil physico-chemical parameters due to the incorporation of the weed mulch for french bean cultivation, this might be due to the decrease of surface run-off during raining day. It also found that the soil temperature which has very less variation lead to the increase of the bacterial count and yield under weed mulch condition. This finding can be attributes to the first decomposition of the weed mulch used which harbour more number of the micro-organism in the soil. Among the selected varieties Selection-9 performed better than the other three varieties.

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