**EFFECT OF VARIOUS MULCHING AND PHOSPHORUS**

**LEVELS IN COWPEA [*Vigna unguiculata* (**[**L.**](https://en.wikipedia.org/wiki/Carl_Linnaeus)**)** [**Walp.**](https://en.wikipedia.org/wiki/Wilhelm_Gerhard_Walpers)**] UNDER GUAVA BASED AGRI-HORTI SYSTEM**

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**ABSTRACT**

A field experiment was performed at Agricultural Research Farm of Rajiv Gandhi South Campus, Barkachha, Mirzapur during Kharif season of 2018-19 to examine the impact of various kinds of mulch on Cowpea (Vigna unguiculata L.) under guava based agri-horti system. The treatments consisted of various types of mulch and different levels of phosphorus i.e. (T1) No mulch + No Phosphorus, (T2) No mulch + 25 kg ha-1 Phosphorus, (T3) No mulch + 50 kg ha-1 Phosphorus, (T4) No mulch + 75 kg ha-1 Phosphorus, (T5) 5t ha-1 Wheat straw mulch + No Phosphorus, (T6) 5 t ha-1 Wheat straw mulch + 25 kg ha-1 Phosphorus, (T7) 5 t ha-1 Wheat straw mulch + 50 kg ha-1 Phosphorus, (T8) 5 t ha-1 Wheat straw mulch + 75 kg ha-1 Phosphorus,(T9) 10 t ha-1 Wheat straw mulch + No Phosphorus, (T10) 10 t ha-1 Wheat straw mulch + 25 kg ha-1 Phosphorus,(T11) 10 t ha-1 Wheat straw mulch + 50 kg ha-1 Phosphorus and (T12) 10 t ha-1 Wheat straw mulch + 75 kg ha-1 Phosphorus. The growth and yield of crop were significantly affected by application of various mulches and different levels of phosphorus. The maximum growth, yield attributes and yield were recorded with the applications of 75 kg P2O5 ha-1along with 10 t ha-1 wheat straw mulch over rest of the treatments. It is concluded that significant growth, yield and yield parameters were obtained with the applications of 75 kg P2O5 ha-1 along with 10 t ha-1 wheat straw mulch under guava based agri-horti system.l

**KEYWORDS- Agri-horti system, Cowpea, Mulch, Phosphorus**

*Cowpea (Vigna unguiculata* L.) is a vital food legume and also primary part of traditional cropping system in the semi-arid regions of the tropics. India is one of the lead producers of pulses in the world and contributes around 27-28 % of global pulse production (Singh *et al.*2016). In India cowpea is used for cooking ‘dal’ as it is rich in 19-26 % protein, 60.3 % carbohydrate, various minerals and vitamins. Mulch is a defensive layer on the ground which decreases the moisture loss from the soil, minimizes the use of nitrogen fertilizers, check soil erosion (Ramakrishna *et al*.2006)Phosphorus is one of the significant nutrients for grain in legumes that helps in nitrogen absorption and a vital constituent of protein and nucleic acid. Legumes have higher phosphorus requirements for growth as well as for nodulation and nitrogen fixation. Guava (*Psidium guajava* L.) belongs to Myrtaceae family and is a common fruit crop which is distributed in tropical and subtropical areas of Africa, South Asia, South East Asia, North America, Australia and New Zealand. It is rich in vitamin C and commonly eaten fresh as fruit desert. Other than vitamin C it is also rich in potassium, thiamine and other dietary fibre. Apart from fruit production, also provides by-products like fuel wood, fodder and timber which are very much useful in daily life of human being. Fruit based agroforestry system is mostly accepted by small scale farmers as it increases net return per unit land from the initial stages of horticultural fruit trees. Agroforestry systems that involve fruit trees are the association of annual or perennial fruit producing trees on the same unit of land. The short juvenile phase and minimum gestation period of the fruit trees increases the market value of the products that are raised in the system. Keeping these in view, the present investigation was carried out to find the effect of various mulching and phosphorus levels in cowpea [*Vigna unguiculata* L. walp.] Under guava based agri-horti system.

**Methodology**

The experiment was conducted at the Agricultural Farm, Rajiv Gandhi South Campus, Barkachha (BHU), Mirzapur under guava based agri-horti system which is situated in the region of Vindhyan (25o10 "latitude, 82o37" longitude and 147 m elevation (higher average sea level) during Kharif season of 2018, having semi-arid to sub-humid climate. The rainfall received during the growing period of crop was 90.97 mm. The soil of the experimental field was sandy loam (sand 56.63%, silt 19.45% and clay 22.00% by black,1967) in texture, poor in organic carbon 0.36%, (Walkley and Black 1934 ), available nitrogen is 150.53kg ha-1, available phosphorus is 7.42kg ha-1 and available potassium is 268.80g ha-1) with low drainage. The experiment was laid out in complete randomized block design with twelve treatments which were repeated thrice assigning twelve treatments consisted of various types of mulch and different levels of phosphorus that is No mulch + No Phosphorus, control (T1), No mulch + 25 kg ha-1 Phosphorus (T2), No mulch + 50 kg ha-1 Phosphorus (T3), No mulch + 75 kg ha-1 Phosphorus (T4), 5 t ha-1 Wheat straw mulch + No Phosphorus (T5), 5 t ha-1 Wheat straw mulch + 25 kg ha-1 Phosphorus (T6), 5 t ha-1 Wheat straw mulch + 50 kg ha-1 Phosphorus (T7), 5 t ha-1 Wheat straw mulch + 75 kg ha-1 Phosphorus (T8) 10 t ha-1 Wheat straw mulch + No Phosphorus (T9) 10 t ha-1 Wheat straw mulch + 25 kg ha-1 Phosphorus (T10) 10 t ha-1 Wheat straw mulch + 50 kg ha-1 Phosphorus (T11) 10 t ha-1 Wheat straw mulch + 75 kg ha-1 Phosphorus (T12). The gross and net plot size were 4.0 × 3.0 = 12 m2 & 3.25 m = 7.5 m2 respectively. The experimental crop was cowpea in alley of guava tree.The variety of cow pea used for experiment ANKUR GOMATI (V.U. 89), a climber type was selected which is recommended for cultivation in kharif season. This variety is having plant height of 150- 230 cm and gets matured in 60-70 days. The test weight of grains is 185-187 g, with a yield potential of 19-20 q ha-1.The variety of guava under agri-horti system is lucknow-49. Nitrogen, phosphorus and potassium were applied in the form of urea(20 kg ha-1 N), SSP and MOP (20 kg ha-1) and K were applied as per treatment ( 25 kg ha-1, 50 kg ha-1 and 75 kg ha-1). Total amount of fertilizers were placed before sowing of the seed in respective plots between the alleys of guava tree as a basal dose. Sowing of certified seeds of cowpea was done with recommended seed rate (20 kg ha-1) at 5 cm depth in open furrows made with a manual single row drilled at a spacing of 60×15 cm and immediately covered with soil.Hand weeding was done at 20 days and 40 days after sowing. Various mulch was spread over the surface as per treatment requirement in a uniform manner. Random sampling technique was adopted for recording growth and development of the test crop at various stages of observation (Gomez and Gomez, 1976). Destructive sampling was done for the study of dry matter accumulation. The observations were recorded at physiological maturity. The observations on growth attributes were recorded at an interval of 20 days i.e. 20th, 40th, 60th days after sowing.Growth parameter of tree speciesis also considered such as tree height, canopy spread, stem girth, shading area. Economics to be calculated are gross return per hectare, net return per hectare and B: C ratio.Data collected on growth, development and quality of the experimental crop was tabulated and statically analysed as per standard analysis of variance to draw valid conclusion (Gomez and Gomez, 1984).

**Effect of straw mulch and phosphorus level on growth attributes**

Effect of straw mulch on growth, basically plant height is a genetically controlled character. But several studies indicated that the plant height can be increased by mulching. It is found that when cowpea treated with 10 t ha-1 wheat straw mulch resulted in maximum growth attributes. It was noted that the plant height increased rapidly till maturity. The rate of growth however, slowed down after 40 DAS to harvest stage due to attainment of reproductive stage. An increase in growth could be due to the preservation of humidity under mulching treatment resulting in higher uptake of water and nutrient by crop. These findings were consistent with Trivedi *et al.* (1994) who noticed that mulching helped in conservation of moisture. In the present investigation, significant differences in plant height, number of branches plant-1 and dry matter production plant-1 were noticed at 20, 40, and 60 and at harvest among the mulched plots. Growth parameters *viz*. plant height, number of branches plant-1 and dry matter production plant-1 increased significantly with the application of 10 t mulch ha-1. The lowest values of growth parameters were recorded when no mulch was applied to the soil. This might be due to absence of mulch which triggered fast water removal from the ground of the land to the prevalent dry micro-environment. High dose of straw mulch (10 t ha-1) evenly covered the land that effectively preserved soil moisture. Greater use of mulch preserved the moisture in soil profile and the crop showed stronger root development resulting in greater dry weight in mulched soil that by Mitra *et al.*(2008).

Phosphorus markedly increased various growth parameter *viz*., plant height, plant spread, dry matter production plant-1, number of trifoliate leaves and number of nodules plant-1. Application of 75 kg P2O5 ha-1 proved significantly superior to rest of the treatments in respect of all the parameters at all the growth stages of cowpea during the investigation. It also enhanced nodule formation and nitrogen fixation by providing root assimilates. Phosphorus affects photosynthesis, protein, phospholipid biosynthesis, nucleic acid synthesis and cytoplasmic streaming. This ensured faster plant growth and development. Increasing phosphorus concentration up to 75 kg ha-1 significantly an enhanced functional leaf especially at subsequent phases whereas, it was found that when cowpea was treated with 0 kg P2O5 ha-1, it resulted in lowest growth attributes. These results showed resemblances with results of Kawwarsa and Yadav (2006), Jain *et al.* (2007); Bhuiyan *et al.* (2008) and Kumawat *et al.* (2010).

**Effect of straw mulch and phosphorus level on yield attributes and yield**

Effect of straw mulch on yield, The values of yield attributes namely number of pods plant-1, number of grain pod-1, pod length and test weight were recorded maximum by the application of 10 t ha-1wheat straw mulch. The seed production mainly depends on yield attributes *viz*. number of pods plant-1, number of grain pod-1, pod length and test weight. These attributes were favorably affected by application of mulch. This may be due to wheat straw mulch helps in moisture conservation, which in result increases the photosynthetic activities and hence increases the yield. As an outcome of increasein8.19 % pod plant-1, 26.62 % number of grain pod-1, 46.80 % pod length and 7.57 % test weight is found by the application of 10 t mulch ha-1. Similar efficacy of wheat straw mulch in improved the yield of mung bean stated by Ghate *et al.* (1994). These finding are in agreement with Surya *et al.* (2000); Siddique *et al.* (2004); Rao *et al.* (2005) and Panchal *et al.* (2006).

Effect of phosphorus on yield, the basic vegetative phase had a significant role in shaping the reproductive organs, which is most important from point of view of obtaining high yield. Number of pods/ plant is largely governed by the number of branches which increased with increasing nutrient levels (Devi *et al.* 2013). Phosphorus significantly influenced the yield attributes and yield *viz*., number of pods plant-1, grains pod-1, pod length (cm), test weight (g), and grain (kg ha-1) yield and harvest index of cowpea during the investigation. Application of 75 kg P2O5 ha-1 was found significantly superior to other levels of phosphorus during the period of investigation. This might be due to better root growth and better translocation of photosynthates resulting in vigorous plant yield. The maximum number of pod plant-1, the number of grain pod-1 and 1000 grain weights, ultimately led to the maximum yield of the grain i.e. 684.28 kg ha-1, by 75 kg ha-1 phosphorus. Bhuiyan *et al.* (2008) reported the outcomes. With implementation of 75 kg ha-1 in comparison to 50 and 25 kg ha-1, the relative greater crop output was achieved owing to enhanced characteristics per crop, i.e. number of grain pod-1 and pod length. Phosphorus level at 75 kg ha-1 recorded 85.83 % higher grain yields than 0kgha-1as a result of increased in number of pod plant-129.93%, number of grain pod-144.02 %, pod length 67.84 %, and test weight 16.61 %. While cowpea when treated with 0 kg ha-1 P2O5 resulted in the lowest yield attributes. This could be due to the plant's compliance with phosphorus requirements. The results were in agreement with the findings of Malik *et al.* (2002) & Khan *et al.* (2002).

**Effect of straw mulch and phosphorus level on economics**

Effect of straw mulch and phosphorus level on economies, the cultivation costs was highest (₹67865.42) in treatment (T12) i.e. application of 10 t ha-1 straw mulch and 75 kg P2O5 ha-1. Critical data assessment showed that the maximum net return (₹188476.41 ha-1) was obtained from treatment (T12) i.e. application of 10 t ha-1 straw mulch and 75 kg P2O5 ha-1. From the above results, it was clear that the net return was higher in treatment (T12) i.e. application of 10 t ha-1 straw mulch and 75 kg P2O5 ha-1. This was because 10 t ha-1 wheat straw mulch contributes much more amount of P2O5, N and K2O as compared to 5 t ha-1 wheat straw mulch and no mulch, which in result increases the grain yield and also helps in increasing the net income with better yield. The results were in agreement with the findings of Sapkota et al. (2015).The highest plant height was obtained with the application of 10 t ha-1 wheat straw mulch when applied with 75 kg P2O5 ha-1 and the lowest with no mulch in combination with 0 kg P2O5 ha-1. The number of trifoliate leaf per plant increased up to maturity i.e. 60 days after sowing. The highest number of leaf (32.31) per plant was obtained with application of 10 t ha-1 wheat straw mulch along with 75 kg P2O5 ha-1 and the lowest (20.44) with no mulch and 0 kg P2O5 ha-1 at 60 DAS. Maximum number of nodules (12.07) per plant was recorded with 10 t ha-1 wheat straw mulch when applied with 75 kg P2O5 ha-1at 30 DAS and lowest number of nodules (1.21) per plant was found with no mulch and no phosphorus application at15 DAS. With the advancement of crop age, dry matter accumulation increased with10 t ha-1 wheat straw mulch along with 75 kg P2O5 ha-1.Higher pod length (20.93 cm), number of pods per plant (30.30), number of grain (10.73) per pod, test weight (98.73 g), grain yield (875.63 kg ha-1) and harvest index(26.33 %) were recorded with 10 t ha-1 wheat straw mulch along with 75 kg P2O5 ha-1 whereas minimum seed (7.45) per pod, test weight (84.66 g), grain yield (157.63 kg ha-1), harvest index (21.28 %) was recorded when no mulch and no phosphorus.10 t ha-1 wheat straw mulch when applied with 75 kg P2O5 ha-1 recorded maximum (0.38%) phosphorus content in grain while it was found to be minimum (0.28%) with no mulch when applied with 0 kg P2O5 ha-1. Maximum uptake of phosphorus (2.83 kgha-1) by grains was recorded with 10 t ha-1 wheat straw mulch with 75 kg P2O5 ha-1 and minimum (0.90 kg ha-1) with no mulch when applied with 0 kg P2O5 ha-1.Maximum (₹ 188477.12 ha-1) net return recorded with 10 t ha-1 wheat straw mulch when applied with 75 kg P2O5 ha-1and minimum(₹ 108585.87 ha-1) net return was recorded with 0 t ha-1 wheat straw mulch when applied with0 kg P2O5 ha-1. The maximum benefit: cost ratio (3.12) was recorded with 10t ha-1 wheat straw mulch when applied with 75 kg P2O5 ha-1 and minimum benefit: cost ratio (2.32) obtained from 0 t ha-1 wheat straw mulch when applied with 0 kg P2O5 ha-1.

**CONCLUSION**

It may be concluded that applications of 10 t ha-1 wheat straw mulch when applied with 75 kg P2O5 ha-1 have pronounced influence on growth attributes, seed yield and maximum net return with cowpea variety Ankur Gomati V.U. 89.Based on above conclusion, it is recommended that applications of 10 t ha-1 wheat straw mulch when applied with 75 kg P2O5 ha-1 should be practiced for higher yield and cowpea under agri-hortisystem in Vindhyan region.

**REFRENCES**

Bhuiyan, M, M, H, Rahman, M, M, Afroz, F, Sutradhar, G, N, C, and Bhuiyan, M, S, I, Effect of phosphorus, molybdenum and rhizobium on growth and nodulation of mung bean, *Journal of Soil Nature,* **2**: 25-30, 2008.

Ghate, R, M, Ravankar, H, N, and Gawande, R, PResidual effect of wheat straw and fertilizers applied to mung on yield and nutrient uptake by wheat*, Annals of Plant Physiology*, **8**(2): 170-173, 1994.

Jain, A, K, and Panwar, S, K, Role of *Rhizobium* on growth, phosphorus and micronutrients and nodulation of green gram (*Vigna radiata* L.), *Advances in Plant Science,* **20**(2): 337- 339, 2007.

Kumawat, a, Pareek, B, L, and Yadav, R, S, Response of green gram (*Vigna radita*) to bio fertilizers under different fertility levels, *Indian Journal of Agricultural Sciences,* **80**(7): 655-657, 2010.

Mitra, B, Manual, B, K, and Hansda, S, K, Effect of paddy straw mulching and varying levels of fertility on root characteristics of rapeseed-green gram-rice crop sequence under rain fed condition*, Crop Research,* **36**(1): 101-104, 2008.

Panchal, H, D, and Patel, J, J, Influence of irrigation schedules (IW: CPE ratio) and mulches on growth and yield of summer green gram under middle Gujarat conditions, *Research on Crops,* **7**(2): 401-403, 2006.

Rao, A, V, Strategies for achieving sustainable production of arid legumes, *Journal of Arid Legumes*, **2**(1): 127-131, 2005.

Sapkota, Anish, Poudel, Sanjok, Subedi, Udaya, Shrivastav, Ruchi, Gairhe, Jaya, Janma, Khanal, Subodh and Pande, Keshab, Raj, Effect of Mulching and Different Doses of Phosphorus in Cowpea (*Vignaunguiculata*L.) Yield and Residual Soil Chemical Properties at Bhairahawa, Nepal, *World Journal of Agricultural Research*, **3**(5): 163-173, 2015.

Siddique, A, Bandyopadhyay, P, and Zaman, A, Effect of irrigation, dates of sowing and mulching on yield attributes, yield and benefit-cost ratio of summer green gram, *Indian Agriculturist*, **48**(3/4): 145-148, 2004.

Singh, A, K, Singh, S, S, Prakash, V, Kumar, S, & Dwivedi, S, K, Pulses Production in India: Present Status sent Status, Bottleneck and Way Forward, *Journal of AgriSearch*, **2**(2), 75-83, 2015.

Surya, J, N, Puranik, R, B, Zadode, S, D, and Deshmukh, S, D, Effect of wheat straw incorporation on yield of green gram and wheat, soil fertility and microbiota, *Journal of Maharashtra Agricultural Universities*, **25**(2): 158-160, 2000.

Table 1 *Yield and yield attributes influenced by mulch and phosphorus level*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatment** | **Pod length (cm)** | **No. of pod per plant** | **No. of grain per pod** | **Test weight (g)** |
| **Wheat straw mulch (t ha-1)** |  |  |  |  |
| 0 | 13.78 | 26.25 | 8.15 | 90.61 |
| 5 | 16.92 | 27.09 | 9.22 | 92.3 |
| 10 | 20.23 | 28.4 | 10.32 | 97.47 |
| SEm ± | 0.54 | 0.99 | 0.29 | 2.97 |
| CD (P=0.05) | 1.57 | 2.9 | 0.85 | 8.72 |
| **Phosphorus (kg ha-1)** |  |  |  |  |
| 0 | 12.47 | 23.32 | 7.45 | 84.66 |
| 25 | 16.07 | 26.27 | 8.79 | 90.79 |
| 50 | 18.44 | 29.1 | 9.95 | 99.65 |
| 75 | 20.93 | 30.3 | 10.73 | 98.73 |
| SEm ± | 0.62 | 1.14 | 0.34 | 3.43 |
| CD (P=0.05) | 1.81 | 3.34 | 0.99 | 10.06 |

Table 2 *Growth and growth attributes influenced by mulch and phosphorus level*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment** | **Plant height (cm)** | **Plant spread plant-1** | **Total dry weight plant-1 (g)** | **Root length plant-1** | **Number of nodules plant-1** |
| **Wheat straw mulch (t ha-1)** |  |  |  |  |  |
| 0 | 122.71 | 46.25 | 8.16 | 10.24 | 4.97 |
| 5 | 171.79 | 48.74 | 10.25 | 16.61 | 5.06 |
| 10 | 231.58 | 54.59 | 12.66 | 19.77 | 5.54 |
| SEm ± | 6.11 | 1.62 | 0.37 | 0.53 | 0.17 |
| CD (P=0.05) | 17.91 | 4.75 | 1.08 | 1.54 | 0.48 |
| **Phosphorus (kg ha-1)** |  |  |  |  |  |
| 0 | 147.54 | 46.88 | 8.97 | 11.56 | 3.79 |
| 25 | 159.23 | 46.54 | 10.18 | 13.62 | 4.96 |
| 50 | 186.97 | 51.3 | 10.87 | 17.56 | 5.64 |
| 75 | 207.7 | 54.73 | 11.4 | 19.42 | 6.38 |
| SEm ± | 7.05 | 1.87 | 0.42 | 0.61 | 0.19 |
| CD (P=0.05) | 20.68 | 5.48 | 1.24 | 1.78 | 0.56 |

Table 3 *Effect of treatments on economics****: Cost of cultivation (₹ ha-1), gross income (₹ ha-1), net return (₹ ha-1) and B: C ratio as influenced by various wheat straw mulch and phosphorus levels***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment** | **Cost of cultivation (₹ ha-1)** | **Gross income (₹ ha-1)** | **Net return (₹ ha-1)** | | **B:C ratio** |
| **Wheat straw mulch (t ha-1)** |  |  |  |  | |
| 0 | 45755.34 | 171960.90 | 126205.56 | | 2.56 |
| 5 | 55755.34 | 200493.30 | 144737.96 | | 2.59 |
| 10 | 65755.34 | 234631.80 | 168876.46 | | 2.75 |
| SEm ± |  | 973.99 | 853.69 | | 0.01 |
| CD (P=0.05) |  | 2856.58 | 2636.15 | | 0.04 |
| **Phosphorus (kg ha-1)** |  |  |  | |  |
| 0 | 53645.96 | 182765.61 | 129119.65 | | 2.42 |
| 25 | 55052.21 | 187798.72 | 132746.51 | | 2.43 |
| 50 | 56458.46 | 202354.14 | 145895.68 | | 2.61 |
| 75 | 57864.71 | 228595.28 | 170730.57 | | 2.97 |
| SEm ± |  | 1124.66 | 1124.66 | | 0.02 |
| CD (P=0.05) |  | 3298.49 | 3298.49 | | 0.05 |