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Effect of weed management and phosphorus nutrition on yield of cowpea (*Vigna unguiculata* L.)

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Abstract

An experiment was conducted at the School of Agriculture Science, Technology Research, Sardar Patel University, Balaghat (M.P.). The present investigation entitled "Effect of weed management and phosphorus nutrition on yield of cowpea (*Vigna unguiculata* L.)" was carried out during year 2024-25. At the Horticultural Research Farm, Sardar Patel University, Balaghat (M.P.). The experiment was laid out in a Randomized block design with 8 treatments and 3 replications. The application of different weed management (herbicide) and phosphorus viz., combinations T₁- Control, T₂-Pendimethalin 750g ha⁻¹ + phosphorus 30 kg ha⁻¹, T₃ -Pendimethalin 750g ha⁻¹ + phosphorus 40 kg ha⁻¹, T₄-Pendimethalin 750g ha⁻¹ + phosphorus 50 kg ha⁻¹, T₅- Imazethapyr 33.75 g ha⁻¹ + phosphorus 30 kg ha⁻¹, T₆-Imazethapyr 33.75 g ha⁻¹ + phosphorus 40 kg ha⁻¹, T₇- Imazethapyr 33.75 g ha⁻¹ + phosphorus 50 kg ha⁻¹ and T₈- Pendimethalin 750 g + Imazethapyr 33.75 g + phosphorus 50 kg ha⁻¹ was used for the experiment. Yield parameters including Total Number of fruit/plants, Average length of pod in (cm), Average Diameter of pod in (cm), Average weight per pod (g), Average fruit yield per plant (kg), Fruit yield per ha (kg), Economic parameter i.e. Cost Benefit Ratio. From the forgoing result, it can be concluded that cowpea grown in different weed management and phosphorus nutrition the treatment T₈ i.e., Pendimethalin 750 g + Imazethapyr 33.75 g + phosphorus 50 kg ha⁻¹ found significant in terms of all yield parameters including pod length, pod diameter, fruit weight per plant, and total yield per hectare, economic parameter, i.e. Cost Benefit Ratio, at the time of harvest. which was statistically at par with T₄ i.e., Pendimethalin 750g ha⁻¹ + phosphorus 50 kg ha⁻¹.

Keywords: Cowpea, weed management, phosphorus, yield attributes, herbicide.

Introduction

The botanical name for cowpea is *Vigna unguiculata*, a warm-season legume in the pea family (Fabaceae) that originated in Africa and is now grown worldwide in tropical and subtropical regions. It is a drought-tolerant annual plant cultivated for its edible seeds, pods, and leaves, which are nutritious and can be used for human food, animal feed, and green manure (Kumar *et al.*, 2025) [1]. Cowpea is one of the important legumes in the world, which plays an important role in the livelihood of millions of people in developing countries (El Naim and Jabereldar, 2010) [2]. As it is a warm-season crop, it is grown throughout the semi-arid regions of the tropics and subtropics. It is known for its versatility as it is used for grain, leaf and forage, cover crop and green manure crop. Being a leguminous pulse, it has high nutritive value and high palatability (Whitebread and Lawrence, 2006). Because of its nitrogen-fixing ability, it is known for improving soil fertility (Abayomi and Abidoye, 2009) [4]. *Vigna* is a pantropical genus with several species. On the basis of dry weight, cowpea is considered to have high biological value and protein content, also known as vegetable meat. Mobilization of insoluble soil nutrients due to its deep root system and improves biological nitrogen fixation (Das *et al.*, 2011) [6]. The ancestor of cowpea is *Vigna unguiculata* var. *mensensii*. There were five distinct subspecies of cowpea, viz. *unguiculata*, *cylindrica*, *sesquipedalis*, *dekinotiana* and *menensis*. Green cowpea pods contain moisture, protein, carbohydrate and fats in amounts of 82.6%, 4.3%, 8.1% and 0.2%, respectively and have a fair amount of calcium, phosphorus, iron, etc. (Aykroyd, 1963) [5]. Cowpea is generally enriched in amino acid profile, particularly lysine, leucine and phenylalanine, which are relatively high in content. Tender fruits contain 80 mg calcium, 74 mg phosphorus and 2.5

mg iron per 100 g fresh (Gopalakrishnan, 2007) [7]. Phosphorus plays a significant role in various physiological processes like root growth and dry matter production, as well as nodulation and nitrogen fixation. In pulse crops, it helps in establishing seedlings quickly and also hastens maturity as well as improves the quality of pulse crops (Mohammed *et al.*, 2021) [8]. The most obvious effect of phosphorus is on the root system of plants. It promotes the formation of lateral and fibrous roots, which facilitates bacteria for nodulation and ultimately increases atmospheric nitrogen fixation in leguminous crops. Phosphorus is one of the important and major nutrients required by crops and soil conditions affect the availability of phosphorus. Nutrient management, particularly phosphorus (P), also plays a crucial role in improving cowpea growth and yield. Phosphorus is a key macronutrient involved in root development, nodulation, energy transfer, and reproductive processes. Being a leguminous crop, cowpea forms symbiotic associations with *Rhizobium* bacteria, and adequate phosphorus nutrition enhances nodulation and biological nitrogen fixation, thereby contributing to better plant vigor and higher yields. However, phosphorus availability in Indian soils is often limited due to fixation, making external supplementation necessary for achieving optimum crop performance. Inadequate and imbalanced application of phosphatic fertilizers by farmers is one of the most important limiting factors in pulse crop production. It is now increasingly being realised that no single nutrient source could fully meet the nutritional requirements of a crop. It has been established that judicious use of chemicals enhances soil and plant health (Singh and Bhullar, 2025) [9]. The low productivity of cowpea can be attributed to several limiting factors. However, among all limiting factors, weed management is most important. Weeds impose competition for nutrients, solar radiation, and water and it sets in at the early crop growth stages and their relative density plays a significant role in reducing crop yield. As regards the various weed control measures, manual eradication has proved its superiority over all the measures in managing weeds; however, the adoption of this technique has not gained popularity as it is time-consuming. Weed interference in cowpea not only reduced the final stand but also the grain yield by up to 90% (Freitas *et al.*, 2009) [10]. The presence of weeds in cowpea reduced the yield to the tune of 60-82% depending on the weed flora and density. The critical period of weed competition in cowpea was 20-25 DAS. Therefore, it is essential to control weeds effectively to harness the maximum yield potential of the crop (Dash *et al.*, 2023) [6, 11].

Material and Methods

The present investigations were carried out to evaluate the “effect of weed management and phosphorus nutrition on yield of cowpea (*Vigna unguiculata* L.)” during the year 2024 at Sardar Patel University, School of Agriculture Science Technology Research, Balaghat (M.P.). The experiment consisted of eight treatments, conducted in a randomized block design with three replications. The application of different weed management (herbicide) and phosphorus viz., combinations T₁- Control, T₂- Pendimethalin 750g ha⁻¹ + phosphorus 30 kg ha⁻¹, T₃ - Pendimethalin 750g ha⁻¹ + phosphorus 40 kg ha⁻¹, T₄- Pendimethalin 750g ha⁻¹ + phosphorus 50 kg ha⁻¹, T₅- Imazethapyr 33.75 g ha⁻¹ + phosphorus 30 kg ha⁻¹, T₆-

Imazethapyr 33.75 g ha⁻¹ + phosphorus 40 kg ha⁻¹, T₇- Imazethapyr 33.75 g ha⁻¹ + phosphorus 50 kg ha⁻¹ and T₈- Pendimethalin 750 g + Imazethapyr 33.75 g + phosphorus 50 kg ha⁻¹ was used for the experiment was used for the experiment.

Cultural practices

Field preparation

The field was prepared by criss-cross ploughing and harrowing. Then the flat beds of dimension 3.6 x 2.4 m were prepared.

Land preparation and seed sowing

The plot selected for the experiment was harrowed, ploughed and cross-ploughed three to four times, followed by laddering to obtain a good tilth. Cowpea variety pusa komal was used as test crop with seed rate 15 kg ha⁻¹ with recommended package of practices. Weeds and stubble were removed and finally obtained a desirable tilth of soil was obtained for sowing. The individual plots were made by making ridges (20 cm high and 50 cm wide) around each plot to restrict lateral runoff of irrigation water and other materials not mixed with treatment or plot to plot.

Watering

Optimal moisture of soil was maintained by watering once a day until germination started. When germination was started the watering was done twice a day (morning and evening).

Observations

Five plants of each plot from each replication were tagged to record the yield i.e. Yield parameters including Total Number of fruit/plants, Average length of pod in (cm), Average Diameter of pod in (cm), Average weight per pod (g), Average fruit yield per plant (kg), Fruit yield per ha (kg), Economic parameter i.e. Cost Benefit Ratio.

Seed yield plant⁻¹ (g)

Seed yield per plant (g) of cowpea is obtained by harvesting a plant, threshing, cleaning, drying the seeds to constant weight, and then weighing them on a balance. The average is usually taken from 5 sampled plants.

$$\text{Seed yield plant}^{-1} (\text{g}) = \frac{\text{Total seed weight from sampled plants (g)}}{\text{Number of plants sampled}}$$

3.5.6. Number of seeds/pod

The number of seed five pods at the maturity stage was counted and recorded. The average number of seed per pod was expressed in numbers.

3.5.7. Yield per plant (kg)

The weight of all pods on a plant at the edible maturity stage of five randomly selected plants in each plot was recorded using a weighing balance and their average is worked out. The average pod yield per plant was expressed in kilograms.

3.5.8. Fruit yield per hectare (kg/ha.)

The yield of fruit per hectare was computed from the per plot yield and was recorded in quintals

$$\text{Fruit Yield (kg /ha)} = \frac{\text{Total Fruit Weight per Plant (g)} \times \text{Plant Population per ha}}{1000000}$$

Results and Discussion

Yield Parameters

The results indicated that weed management and phosphorus nutrition had a significant effect on pod characteristics of cowpea. The maximum average pod weight (16.11 g) was recorded in T₈ (Pendimethalin 750 g + Imazethapyr 33.75 g + phosphorus 50 kg ha⁻¹), followed by T₄ (13.21 g). The minimum pod weight (9.67 g) was observed in T₁ (control, weedy check). The maximum pod diameter (1.08 cm) was also recorded in T₈ and was statistically at par with T₄ (1.01 cm), T₇ (0.99 cm), and T₃ (0.93 cm). The minimum pod diameter (0.56 cm) was recorded in T₁. The highest number of pods per plant (11.16) was obtained in T₈, followed by T₄ (10.17) and T₇ (8.52). The minimum number of pods per plant (6.26) was recorded in T₁. Similarly, the maximum pod length (20.48 cm) was recorded in T₈, while the minimum (16.15 cm) was observed in T₁. Overall, T₈ proved to be the most effective treatment for improving pod weight, diameter, number, and length in cowpea. The results showed that weed management and phosphorus nutrition significantly influenced the yield attributes and yield of cowpea. The maximum number of seeds per pod (13.08) was recorded in T₈ (Pendimethalin 750 g + Imazethapyr 33.75 g + phosphorus 50 kg ha⁻¹). T₈ was statistically at par with T₄ (11.50) and T₇ (11.21). The minimum number of seeds per pod (8.83) was recorded in T₁ (control, weedy check). The maximum seed yield per plant (32.30 g) was also obtained in T₈, followed by T₄ (29.88 g) and T₇ (25.96 g). The minimum seed yield per plant (20.74 g) was recorded in T₁. Similarly, the highest pod yield per plant (8.93 kg) was recorded in T₈, followed by T₄ (7.98 kg) and T₇ (7.53 kg). The lowest yield per plant (5.50 kg) was observed in T₁. The pod yield ranged from 1308.66 to 3005.66 kg ha⁻¹. The maximum pod yield (3005.66 kg ha⁻¹) was recorded in T₈, whereas the minimum (1308.66 kg ha⁻¹) was recorded in T₁.

Overall, T₈ was found to be the most effective treatment for enhancing seed and pod yield of cowpea.

Analysis of cost of cultivation

The gross returns were depending upon the yield, market demand and quality of cowpea pods which are produced and sell. Varieties are also a factor affecting gross return depends upon their demand in market. The maximum gross return was found in the treatment T₈ (Rs. 147350.00) because of the herbicide application is recommended dose and phosphorus combinations (Pendimethalin 750 g + Imazethapyr 33.75 g + phosphorus 50 kg ha⁻¹) they are small in quantity and high in price compare to manual weeding and bulky manure. The minimum gross return was found in the treatment T₁ Control (Rs. 40275). The price of the cowpea is 2500/q.

Benefit: Cost ratio

The average net return or the maximum net profit of Rs. 84,350 ha⁻¹ was obtained under treatment T₈ (Pendimethalin 750 g + Imazethapyr 33.75 g + phosphorus 50 kg ha⁻¹) which was closely followed by treatment T₇ (Imazethapyr 33.75 g ha⁻¹ + phosphorus 50 kg ha⁻¹) with net profit of Rs. 54,764 ha⁻¹. Minimum net profit was found in treatment combination T₁ (Control) with net profit of Rs. 5275.00 ha⁻¹. The economics of various treatment with benefit 2.33 cost ratio are given in Table 4.10. The net profit from cultivation under different treatments was worked out after subtracting the cost of cultivation from gross return.

Conclusion

From the foregoing results, it can be concluded that cowpea grown in a different weed management and phosphorus nutrition Pendimethalin 750 g + Imazethapyr 33.75 g + phosphorus 50 kg ha⁻¹ i.e., T₈ gave the best results in terms of yield parameter i.e., Total Number of fruit/plants, Average length of pod in (cm), Average Diameter of pod in (cm), Average weight per pod (g), number of seed per pod, seed yield per plant, Average fruit yield per plant (kg), Fruit yield per ha (kg), Economic parameter i.e. Cost Benefit Ratio.

Table 1: Effect of different weed management and phosphorus on yield parameters of cowpea.

Treatment	Average weight per pod (g)	Average diameter of pod in (cm)	No. of pods plant ⁻¹	Length of pods in (cm)
T ₁ :Control (weedy, No application)	9.67	0.56	6.26	16.15
T ₂ :Pendimethalin 750g ha ⁻¹ + phosphorus 30 kg ha ⁻¹	10.07	0.75	6.56	16.62
T ₃ :Pendimethalin 750g ha ⁻¹ + phosphorus 40 kg ha ⁻¹	10.65	0.93	7.09	17.34
T ₄ :Pendimethalin 750g ha ⁻¹ + Phosphorus 50 kg ha ⁻¹	13.21	1.01	10.17	19.68
T ₅ :Imazethapyr 33.75 g ha ⁻¹ + phosphorus 30 kg ha ⁻¹	10.73	0.62	6.56	16.80
T ₆ :Imazethapyr 33.75 g ha ⁻¹ + phosphorus 40 kg ha ⁻¹	12.42	0.85	7.45	17.97
T ₇ :Imazethapyr 33.75 g ha ⁻¹ + phosphorus 50 kg ha ⁻¹	12.87	0.99	8.52	19.25
T ₈ :Pendimethalin 750 g + Imazethapyr 33.75 g + phosphorus 50 kg ha ⁻¹	16.11	1.08	11.16	20.48
SEM ±	0.39	0.05	0.46	0.27
CD at 5 %	1.22	0.162	1.42	0.85

Table 2: Effect of different weed management and phosphorus on seed parameters and B:C of cowpea.

Treatment	Number of seeds per pod	Seed yield plant ⁻¹ (g)	Yield per plant (kg)	Fruit yield (kg ha ⁻¹)	Benefit: Cost ratio
T ₁ :Control (weedy, No application)	8.83	20.74	5.50	1,308.66	1.15
T ₂ :Pendimethalin 750g ha ⁻¹ + phosphorus 30 kg ha ⁻¹	9.08	22.73	6.04	1,617.33	1.86
T ₃ :Pendimethalin 750g ha ⁻¹ + phosphorus 40 kg ha ⁻¹	9.57	24.23	6.26	1,938.33	2.20
T ₄ :Pendimethalin 750g ha ⁻¹ + Phosphorus 50 kg ha ⁻¹	11.50	29.88	7.98	2,698.00	2.09
T ₅ :Imazethapyr 33.75 g ha ⁻¹ + phosphorus 30 kg ha ⁻¹	9.39	21.61	5.74	1,564.66	1.24
T ₆ :Imazethapyr 33.75 g ha ⁻¹ + phosphorus 40 kg ha ⁻¹	9.35	23.14	6.75	1,646.00	2.13
T ₇ :Imazethapyr 33.75 g ha ⁻¹ + phosphorus 50 kg ha ⁻¹	11.21	25.96	7.53	2,625.33	2.06

T ₈ :Pendimethalin 750 g + Imazethapyr 33.75 g + phosphorus 50 kg ha ⁻¹	13.08	32.30	8.93	3,005.66	2.33
SEm ±	0.37	0.37	0.29	43.13	
CD at 5 %	1.13	1.13	0.91	132.09	

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