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EFFECT OF ORGANIC IN-ORGANIC FERTILIZERS ON YIELD AND QUALITY OF COWPEA (*VIGNA UNGUICULATA* L. WALP.)

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ABSTRACT

The present investigation, titled "Influence of Integrated Nutrient Management on Growth and Seed Yield of Cowpea (*Vigna unguiculata* L. Walp.)," aimed to evaluate the effect of organic and biofertilizer combinations on the growth and yield of the cowpea variety Pusa Komal. Conducted at the Horticulture Department Field, School of Agriculture Research and Technology, Sardar Patel University, Balaghat (M.P.), during the *Kharif* season of 2023, the experiment was designed using a Randomized Block Design (RBD) with 9 treatments, each replicated three times. The treatments were as follows: T_0 (Control - Water spray); T_1 (100% RDF [NPK: 25:50:25 Kg/ha]); T_2 (100% Farmyard Manure - FYM); T_3 (100% Vermicompost - VC); T_4 (100% Poultry Manure - PM); T_5 (75% RDF + 25% FYM); T_6 (75% RDF + 25% VC); T_7 (75% RDF + 25% PM); and T_8 (25% RDF + 25% FYM + 25% VC + 25% PM). The results clearly revealed that T6 (75% RDF + 25% VC) performed best in terms of vegetative growth (plant height, number of branches per plant), yield attributes (number of pods per plant, pod weight, pod yield), and economic returns, showing the highest net return and benefit-cost ratio. Thus, the integrated use of nutrients, particularly the T6 treatment, can be recommended for enhanced cowpea productivity under Balaghat (M.P.) conditions.

Key words : Cowpea, DAP, FYM, VC, PM and Benefit cost ratio.

Introduction

Botanically known as *Vigna unguiculata* (L.) Walp, commonly referred to as Cowpea, this annual herbaceous legume belongs to the genus Vigna. Its ability to thrive in sandy soil and low rainfall conditions makes it a vital crop in the semiarid regions of Africa and Asia. Cowpea requires minimal inputs since its root nodules can fix atmospheric nitrogen, making it beneficial for resource-poor farmers and ideal for intercropping with other crops. The entire plant serves as forage for animals, with its use as cattle feed likely leading to its name. There are numerous varieties of cowpea, each with distinct fruit shapes. As a diploid species with a somatic chromosome number of 2n=22, cowpea is one of the most significant pulse crops originating from West Africa (Venkatesan *et al*., 2003). Known as the "poor man's meat" or "vegetable meat" due to its high protein content, cowpea's young leaves, pods and peas are rich in vitamins and minerals, making them valuable for both human consumption and animal feed. Cowpea can endure significant drought and high rainfall, and it can be cultivated in almost any soil type, provided there is adequate drainage. Cowpea is primarily cultivated in tropical and subtropical regions worldwide for both vegetable and grain purposes and to a lesser extent as a fodder crop. It is considered a highly versatile pulse crop due to its smothering nature, drought tolerance, soil-restoring properties, and multipurpose uses. Cowpea integrates well into various cropping systems and is grown for its seeds (both green and dried), pods, and leaves, which are consumed fresh as green vegetables. Additionally, snacks and main dishes are prepared from the dried grain (Kumar and Shrikant, 2017). There are four recognized subspecies of cowpea, with three being cultivated. The species exhibits significant morphological diversity, with large variations in plant size, shape, and structure. Cowpeas can grow erect, semi-erect (trailing), or climbing. While the crop is mainly cultivated for its protein-rich seeds, the leaves and immature seed pods are also edible. Growth conditions and preferences for each variety vary by region (Padulosil, 1997). Despite its morphological diversity, cowpea's genetic diversity within varieties is relatively low due to its primarily self-pollinating nature (Egbadzor *et al*., 2014).

The optimum temperature for cowpea growth is 30°C, making it suitable primarily as a summer crop in many parts of the world. It thrives best in regions with an annual rainfall of 400 to 700 mm. Cowpeas prefer sandy soils and are more tolerant of infertile and acidic soils compared to many other crops. Seeds can be harvested approximately 100 days after planting, or the whole plant can be used as forage after about 120 days. Leaves can be picked as early as four weeks after planting. Cowpeas are mainly cultivated for their edible beans, but the leaves, green seeds, and pods are also consumable, allowing the plant to serve as a food source before the dried peas are harvested (Ehlers and Hall, 1997). Like other legumes, cowpeas need to be cooked to be edible, typically by boiling. They can be used in various dishes such as stews, soups, purees, casseroles, and curries and can also be processed into a paste or flour (Goncalves *et al*., 2016). Chinese long beans, a variety of cowpea, can be eaten raw or cooked. However, they easily become waterlogged and are usually sautéed, stir-fried, or deep-fried.

Cowpea plays a significant role in human nutrition, offering high nutritive value. Per 100 grams of the edible portion, cowpea contains 60.03 g of carbohydrates, 23.52 g of protein, 10.6 g of dietary fibre, 184 mg of magnesium, 16 mg of sodium, 1.5 mg of vitamin C, 424 mg of phosphorus, 8.27 mg of iron, 110 mg of calcium, 1152 mg of potassium, 3 µg of vitamin A, and 633 µg of folate (B_9), along with many other nutrients (Choudhary, 2013). Cowpea is widely cultivated in South and Southeast Asian countries, including India, Bangladesh, Pakistan, China, and the Philippines. In India, the area under cowpea cultivation reached 1.5 million hectares with a production of 2.25 million metric tonnes in 2021-22. Maharashtra ranked first in both area and production of cowpea in 2021-22, followed by Andhra Pradesh and Karnataka. In Madhya Pradesh, the area under cowpea cultivation was 0.23 thousand hectares, with production estimated at 8.13 million tonnes for 2021-22 (NHB, 2022).

Farm manure, primarily composed of cow dung, cow urine, straw and other dairy waste, offers a small amount of nitrogen (N) directly available to plants. As farmyard manure (FYM) decomposes, more nitrogen becomes available. Mixing cow dung with urine provides a balanced nutrient diet for plants. Vermicompost, produced through earthworm activity, is rich in NPK (nitrogen at 2-3%, phosphorus at 1.55-2.25%, and potassium at 1.85-2.25%) and contains numerous micronutrients and beneficial soil microbes.

Materials and Methods

The present investigation was done to understand the Effect of Organic In- organic Fertilizers on yield and Quality of Cowpea under Balaghat climatic conditions. The experiment was laid out in Randomized Block Design (RBD) with 08 treatments and three replications. For this purpose, 24 plots were made in Horticulture Research Farm. The details of the materials used, and the procedures adopted in the investigation, which was carried out at Field of Horticulture Department, School of Agriculture Research and Technology, Sardar Patel University, Balaghat, (M.P.) during the *Kharif* season of 2023 are described under the following heads. Balaghat District is located the south-eastern portion of the Satpura Range and the upper valley of the Wainganga River. The district extends from 21°19' to 22°24' North latitude and 79°31' to 81°30' East longitude. The treatment combination used for evaluation comprised of 100% RDF , 100% FYM , 100% Vermicompost, 75% RDF + 25% FYM, 75% RDF + 25% Vermicompost , 50% RDF + 50% FYM , 50% RDF + 50% Vermicompost . The height of five randomly selected tagged plants from each plot was measured in centimeters using a meter scale at 30 and 50 days after sowing (DAS), from the ground level to the tip of the shoot. The average plant height for each replication was recorded and subjected to statistical analysis. At maturity, the number of branches on randomly selected plants from each plot was counted. The average number of branches per plant for each replication was recorded and subsequently analyzed statistically. The number of days from sowing to the appearance of the first male flower in the experimental plots was recorded as the days to 50% flowering. The data were averaged and analyzed across all replications. Days to first pod setting in the experimental plots was defined as the number of days from seeding to the appearance of the first pods. Data were collected for each replication, averaged, and analyzed. The number of days from sowing to the first pod picking was counted for five experimental plants, and the data were averaged and analyzed across all replications. The number of pods that set on each vine was counted and recorded for each treatment and replication. The recorded data were then subjected to analysis. Average pod length was measured from five randomly selected pods on randomly chosen plants using a measuring tape and scale. The data were then averaged and subjected to statistical analysis. Average pod weight was taken from randomly five pods from randomly selected plants by using physical balance, averaged, and subjected to statistical analysis. The pod weight of the tagged plants was recorded at each harvest. The weights were then averaged and analyzed. The yield was calculated by weighing the marketable pods. Data for all two plants per plot were recorded, and the average yield per plant was determined by dividing the total yield of each treatment by the total number of plants in the plot. The ascorbic acid (vitamin C) content of the pulp was calculated using 2, 6-dichlorophenol indophenol dye, following the method described by Ranganna (1986). Benefit cost ratio = Gross return (Rs/ha) / Total cost of cultivation (Rs/ha). The data recorded during the experimental investigation were subjected to statistical analysis using the “Analysis of Variance” (ANOVA) technique (Fisher and Yates, 1967).

Results and Discussion

Plant height

The maximum plant height (57.85 and 96.28 cm) at 30, 50 DAS respectively was observed with treatment T_5 (75%RDF + 25% FYM) followed by T_6 (75% RDF + 25% VC) with 54.95 and 95.31 cm at 30, 50 DAS respectively. Minimum height of plant (42.29 and 80.43 cm) was observed in T_1 (control) at 30, 50 DAS respectively, while the remaining treatments were moderate in their growth habit. In cowpea cultivation, The superior plant height of cowpea observed in Treatment T_5 (75% RDF + 25% FYM) compared to other treatments can be attributed to the synergy between the rapid nutrient availability of RDF and the soil-enhancing properties of FYM. RDF provides readily available essential nutrients like nitrogen, phosphorus, and potassium, which are critical for early plant development, vigorous growth, and overall height. By supplying 75% of the recommended dose, the plants receive sufficient nutrients to support optimal growth without nutrient limitations. The addition of 25% FYM (Farmyard Manure) enhances soil structure, water retention, and microbial activity. FYM enriches the soil with organic matter, improving the root zone environment and aiding in nutrient absorption. This combination creates a balanced system where the cowpea plants benefit from both the immediate nutrient availability of RDF and the long-term soil health benefits of FYM. Compared to 100% RDF (T_2), the incorporation of FYM boosts soil fertility and microbial diversity, enhancing nutrient uptake efficiency. This leads to taller plants in Treatment 5. While treatments with 100% organic matter (FYM or vermicompost) provide slower nutrient release, the mixture of RDF with organic matter offers the most favorable conditions for cowpea height. Similar findings were reported by Panda *et al.* (2017); Patel *et al.* (2021) in cowpea.

Number of branches per plant

Number of branches per plant of cowpea showed statistically significant differences present among various doses of combination applied. The maximum number of branches per plant (15.85 branches) was observed with treatment T_5 (75%RDF + 25% FYM) followed by T_6 (75% RDF + 25% VC) (15.30 Branches) .Minimum number of branches per plant (8.73 branches) was observed in T_1 (control). The number of branches per plant in cowpea is significantly influenced by nutrient management practices, particularly when comparing the treatment of 75% Recommended Dose of Fertilizers (RDF) combined with 25% Farmyard Manure (FYM) to other treatments. This combination provides a balanced supply of both inorganic and organic nutrients, promoting optimal plant growth. This balanced nutrient availability contributes to more robust vegetative growth, ultimately increasing branch numbers per plant. Similar findings were reported by Singh *et al.* (2018); Patel *et al.* (2023) in cowpea.

Days to 1st and 50% flowering

The minimum days to 50% flowering (43.64 days) was observed with treatment T_5 (75%RDF + 25% FYM) followed by T_6 (75% RDF + 25% VC) with 45.48 days. Maximum days to 50% flowering (51.21days) was observed in T_1 (control). In cowpea cultivation, the number of days to 50% flowering in cowpea is significantly influenced by the nutrient management strategy, particularly the combination of 75% Recommended Dose of Fertilizers (RDF) with 25% Farmyard Manure (FYM). This treatment offers a balanced nutrient supply, ensuring both immediate and gradual nutrient release. The RDF portion provides readily available macronutrients like nitrogen, phosphorus, and potassium, which are essential for early vegetative growth and flowering initiation. Thus, the 75% RDF + 25% FYM treatment ensures a steady nutrient supply, encouraging cowpea plants to reach the flowering stage more efficiently compared to other treatments, resulting in fewer days to 50% flowering. Similar findings were reported by Begam *et al.* (2023); Indianraj *et al.* (2023) in cowpea.

Days to 50% pod setting and days to first pod picking

The minimum days to 50% pod setting (50.59 days) was observed with treatment T_5 (75%RDF + 25% FYM) followed by T_6 (75% RDF + 25% VC) with (52.48 days) days. Maximum days to 50% pod setting (62.41days) was observed in T_1 (control). Days to first pod picking in cowpea showed statistically significant differences present among various doses of combination applied. The minimum days to first pod picking (62.03 days) was observed with treatment T_5 (75%RDF + 25% FYM) followed by T_6 (75% RDF + 25% VC) with 64.20 days. Maximum days to first pod picking (74.85 days) was observed in T_1 (control). The number of days to 50% pod setting in cowpea is closely influenced by the nutrient management practices, particularly the combination of 75% Recommended Dose of Fertilizers (RDF) and 25% Farmyard Manure (FYM). Compared to 100% RDF, which may provide excessive nutrients in the early stages, leading to delayed reproductive processes, or to treatments with higher organic matter that might slow down nutrient availability, the 75% RDF + 25% FYM combination, achieves a balanced nutrient supply. This balance ensures efficient transition from flowering to pod setting, promoting better reproductive efficiency. Similar findings were reported by Singh *et al*. (2017); Patel *et al*. (2023) in cowpea.

Number of Pod per plant

Number of pods per plant of cowpea showed statistically significant differences present among various doses of combination applied. The maximum number of pods per plant (27.40 pods) was observed with treatment T_5 (75%RDF + 25% FYM) followed by T_6 (75% RDF + 25% VC) with 24.94 pods. Minimum number of pods per plant (17.41 pods) was observed in T_1 (control). The number of pods per plant in cowpea is significantly influenced by the nutrient management strategy, with the treatment of 75% Recommended Dose of Fertilizers (RDF) and 25% Farmyard Manure (FYM) yielding superior results compared to other treatments. This combination provides an optimal nutrient balance, supporting both vegetative and reproductive growth. The 75% RDF supplies essential macronutrients like nitrogen, phosphorus, and potassium in adequate amounts, promoting vigorous vegetative growth and strong flowering. These nutrients are readily available and crucial for the early growth stages of cowpea. However, when combined with 25% FYM, the organic component further enhances soil fertility by improving soil structure, increasing microbial activity, and providing a slow release of nutrients. FYM also improves moisture retention, which is particularly beneficial during pod development. In contrast, treatments with 100% RDF may supply nutrients in excessive quantities, leading to overly vegetative plants with reduced reproductive output. On the other hand, organic treatments alone may result in delayed nutrient availability, which can slow down pod formation. The balanced nutrient availability from 75% RDF + 25% FYM ensures that cowpea plants receive a steady supply of nutrients throughout their growth cycle, leading to more flowers setting pods and ultimately increasing the number of pods per plant compared to other treatments. Similar findings were reported by Panda *et al.* (2017); Patel *et al.* (2023) in cowpea.

Pod length and individual pod weight

The maximum pod length (21.57 cm) was observed with treatment T_5 (75%RDF + 25% FYM) followed by T_6 (75% RDF + 25% VC) with 19.88 cm. Minimum pod length (16.29 cm) was observed in T_1 (control). The maximum pod weight (16.51 grams) was observed with treatment T_5 (75%RDF + 25% FYM) followed by T_6 (75% RDF + 25% VC) with 15.77 grams. Minimum pod weight (11.15 grams) was observed in T_1 (control). In cowpea cultivation, the treatment combination of 75% Recommended Dose of Fertilizers (RDF) + 25% Vermicompost (VC) often results in better pod length and individual pod weight, ranking second only to the RDF 100% treatment among various integrated nutrient management strategies. This improvement can be attributed to the balanced nutrient supply and soil health benefits provided by this combination. Vermicompost enriches the soil with organic matter, beneficial microorganisms and nutrients, which improve soil structure, fertility and nutrient availability. This supports healthy root development and efficient nutrient uptake by cowpea plants. The 75% RDF ensures adequate but not excessive provision of essential nutrients such as nitrogen, phosphorus and potassium, crucial for pod formation and growth. The synergistic effects of FYM and balanced RDF application enhance plant vigor, promote uniform flowering and facilitate optimal pod development. This results in longer pods with higher individual pod weights compared to other integrated nutrient management approaches, thereby contributing to improved yield and quality in cowpea cultivation. Similar findings were reported by Pushpa *et al.* (2022); Patel *et al.* (2023) in cowpea.

Pod yield per plant and pod yield per hectare

The maximum pod yield per plant (452.88 g/plant) was observed with treatment T_5 (75%RDF + 25% FYM)

Table 1 : Effect of Organic in- organic Fertilizers on yield and Quality of cowpea.

Variety Symbols	Treatment details	Plant height (cm)		Number of Branches per plant	Days to 50 % flowering	Days to 50% pod setting	Days to first pod picking	No of pods per plant	Pod length (cm)	Individual Pod weight (grams)	Pod yield per plant (g/plant)	Pod yield per hectare (t/ha)	Vitamin C content (mg)	B:C ratio
		At 30 DAS	At 50 DAS											
T_1	Control	42.29	80.43	8.73	51.21	62.41	74.85	17.41	16.29	12.47	154.43	3.79	3.53	1.33
T_2	100% RDF	51.57	91.66	14.33	50.41	54.34	64.72	23.88	18.51	15.22	363.60	5.90	6.50	1.98
T_3	100%FYM	51.72	88.99	13.33	48.17	57.18	64.25	17.10	15.23	14.10	238.40	4.32	6.14	1.24
T_4	100% Vermicompost	50.38	88.12	11.65	44.63	53.16	66.41	16.94	17.89	14.63	237.57	5.37	5.65	1.65
T_5	75%RDF+25%FYM	57.85	96.28	15.85	43.64	50.59	62.03	27.40	21.57	16.51	452.88	6.52	7.40	2.10
T_6	75%RDF +25% Vermicompost	54.95	95.31	15.30	45.48	52.48	64.20	24.94	19.88	15.77	393.42	6.39	7.24	2.09
T_7	50%RDF+50% FYM	54.43	85.84	8.92	45.74	54.4	65.65	21.61	16.95	14.07	316.30	6.10	5.34	1.89
T_8	50%RDF +50%	46.61	84.82	7.15	44.04	52.50	63.87	21.85	19.03	13.64	307.68	5.27	4.86	1.66
	Vermicompost													
	$CD_{0.05}$	**2.97**	**3.22**	**0.58**	**1.81**	**1.93**	**3.14**	**1.56**	**0.55**	**0.81**	**29.90**	**0.25**	**0.39**	
	SE.m(±)	**1.00**	**1.08**	**0.19**	**0.61**	**0.65**	**1.06**	**0.53**	**0.18**	**0.27**	**10.06**	**0.08**	**0.13**	

followed by T_6 (75% RDF + 25% VC) with 393.42 g/plant. Minimum pod yield per plant (154.43 g/plant) was observed in T_1 (control). The maximum pod yield per hectare (6.52 t/ha) was observed with treatment T_5 (75%RDF + 25% FYM) followed by T_6 (75% RDF + 25% VC) at par with T_6 (75% RDF + 25% VC 50%) with 6.39 t/ha. Minimum pod yield per hectare (3.79 t/ha) was observed in T_1 (control). In cowpea farming, the combination of 75% Recommended Dose of Fertilizers (RDF) and 25% FYM typically leads to higher pod yields, ranking second only to the RDF 100% treatment among various integrated nutrient management strategies. This enhanced pod yield can be attributed to the synergistic benefits of organic and inorganic inputs in this blend. FYM enriches the soil with organic matter, beneficial microorganisms, and essential nutrients, which improve soil structure, fertility and water retention. This creates favorable conditions for root growth and nutrient uptake in cowpea plants. The 75% RDF ensures a balanced supply of crucial nutrients like nitrogen, phosphorus, and potassium, promoting healthy vegetative growth and reproductive development. The combined effect of FYM and balanced RDF application optimizes flowering, pod formation and filling, resulting in increased pod yield per plant. This approach enhances nutrient utilization efficiency and overall plant health, contributing to improved pod yield in cowpea compared to other integrated nutrient management strategies. Similar findings were reported by Indianraj *et al.* (2023) in cowpea.

Vitamin C content

The maximum vitamin C content (7.40 mg) was observed with treatment T_5 (75%RDF + 25% FYM) followed by T_6 (75% RDF + 25% VC) with 7.24 mg. Minimum vitamin C content (3.53 mg) was observed in T_1 (control). In cowpea cultivation, the treatment combinations of 75% Recommended Dose of Fertilizers (RDF) + 25% Farm Yard Manure (FYM) often exhibit higher vitamin C content, ranking second after the RDF 100% treatment among various integrated nutrient management strategies. This increase in vitamin C content can be attributed to the balanced nutrient supply and soil health benefits provided by these combinations. FYM enriches the soil with organic matter, beneficial microorganisms and essential nutrients, improving soil fertility and enhancing nutrient availability to cowpea plants. The balanced application of RDF ensures that plants receive adequate nitrogen, phosphorus and potassium without excess, supporting optimal growth and nutrient uptake. The synergistic effects of VC with either FYM enhance nutrient efficiency and promote biosynthesis of vitamin C in cowpea plants. This results in higher vitamin C content in the pods, contributing to improved nutritional quality compared to other integrated nutrient management approaches. Similar findings were reported by Patel *et al.* (2023) in cowpea.

Economic parameter

Maximum cost of cultivation incurred in treatment T_3 (Farmyard manure (FYM) 100%) with (Rs 1,04,125ha^{-1}) and the minimum (Rs 85,375ha^{-1}) was recorded in treatment T_1 (Control). Maximum gross returns were recorded in treatment T_5(75% RDF + 25% FYM) with (Rs 195600ha^{-1}) followed by T_6 (75% RDF + 25% VC) having Rs 191700 ha^{-1} and the minimum (Rs 113700ha^{-1}) was recorded in treatment T_1 (Control). Maximum net returns were recorded in treatment T_5 (75% RDF+25% FYM) with (Rs 1,02,603 ha^{-1}) followed by T_6 (75% RDF + 25% VC) having Rs 1,00,391 ha^{-1} and the minimum (Rs 28,225ha^{-1}) was recorded in treatment T_1 (Control). Maximum benefit cost ratio was recorded in treatment T_5 (75% RDF+25% FYM) with (2.10) followed by T_6 (75% RDF + 25% VC) having 2.09 and the minimum (1.33) was recorded in treatment T_1 (Control). Similar findings were reported by Singh *et al.* (2018) in cowpea.

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