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GROWTH AND YIELD RESPONSES OF COWPEA TO ORGANIC AND CHEMICAL NUTRIENTS UNDER INTEGRATED NUTRIENT MANAGEMENT APPROACH

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SUMMARY

Finding a sustainable crop nutrient management system is vital to restoring sustainable soil health without compromising yield potential from existing fertilizer resources while excessive chemical fertilizers application hazards to soil environment. In the light of this background, the present study assess the advantages of using organic manures apply to the soil as a sustainable way to replace the chemical fertilizers quantity while maintaining growth and development of cowpea (*Vigna unguiculata* L.). Two years field studies were conducted as part of all India coordinated research project on vegetable crop during *kharif* season on variety Kashi Kanchan. Nine treatments were used in the experiment replicated three times and arranged in randomised block design. The outcome of the two years experimental data impart that the application of poultry manure at 2.5 t/ha along with 50% recommended dose of NPK through chemical fertilizers proved superior in growth parameters plant highest plant height (69.43 cm) and branches (7.05/ plant). The yield contributing factors, number of pods per plant, green pod length, green pod girth and green pod yield (175.35 q/ ha) were recorded significantly higher in the same treatment, the results were found that growth and yield parameters exhibited at par with application of neem cake at 2.5 q/ha along with 50% recommended dose of NPK through chemical fertilizers. The highest gross returns, net returns and benefit cost ratio (2.0) were also recorded in poultry manure at 2.5 t/ha along with half recommended dose of NPK through chemical fertilizers. Based on two years results concluded that an integrated nutrient management program using alternative application of both organic and chemical fertilizers recommended for achieving higher economical returns of cowpea and environmentally safe.

Key words: Neem cake, organic fertilizer, poultry manure, soil fertility, vermicompost

Cowpea is one of the most significant warm season *kharif* vegetable legume crops adaptable to various humid tropical and subtropical climates, cowpea is also an alternative crop for dry land agriculture. The tender green pods are utilised as a vegetable and as fodder because of their leaves (Singh *et al*. 2003; Gomes *et al*. 2021). According to Langyintuo *et al*. (2003) and Kimiti *et al*. (2011) cowpea is frequently used for pasture, nutritional food as a source of protein, revenue creation and soil fertility enhancer through biological nitrogen fixation. There is a common understanding that integrated plant nutrition systems are necessary to sustain crop productivity and preserve soil health and that single reliance on chemical fertilizers input based agriculture is unsuitable in the long run. The idea behind in sustainable nutrient management system is to maintaining the availability of nutrients to plants while optimising the assistance of all possible sources of plant nutrients in a coordinated way (Sunita *et al*. 2022). The fertility of the soil is increased by the both organic and inorganic fertilizers application alternatively, which causes lowers the cost of production and increase net returns to the farmers. In order to meet the nutritional requirements for plants and minimising any negative effects on the soil and environment under such circumstances organic compost is a crucial tool (Sayara *et al*., 2020). It is evidenced that integrated plant nutrition systems are essential for maintaining crop productivity and safeguarding soil health and that relying solely on chemical input-based agriculture is unsuitable for long

term. Organic fertilizers such as farmyard manure (FYM), neem cake, vermicompost and poultry manure are valuable soil amendments that can enhance soil fertility by releasing nutrients gradually over time, providing a consistent source of nutrition to the crops, which are improve soil structure, helping the soil retain moisture, promote the growth and activity of beneficial soil microorganisms and less likely to cause environmental pollution compared to synthetic chemical fertilizers and aligns with sustainable agricultural practices. However, in the case of cowpea, the particular advantages of organic fertilizers can differ according on soil type, climate, crop type and the kind of organic fertilizer going to use (Abdel-Rahman *et al.*, 2009; Omer *et al.*, 2023). It is also essential to apply organic fertilizers in appropriate quantities at right time to maximize the crop yield. In light of sustainable development objects of the experiment was to examine the impact of various organic fertilizers solely and combination with chemical fertilizers effectiveness on nutrient management of cowpea to sustain the supply of plant nutrients in a coordinated manner.

MATERIALS AND METHODS

A field experiment was undertaken under all India coordinated research project - vegetable crops (AICRP-VC) in the experimental research farm of Regional Research Station of the National Horticultural Research and Development Foundation, Karnal, Haryana, which is located between 29.7'-86.7' N latitude and 76.9'-86.41' E longitude at an altitude of 243 m above the mean sea level. The Fig 1. depicted temperature, relative humidity and rainfall of experimental area. The experimental region falls in subtropical climate and the soil is deep, well-drained, neutral to alkaline in response (pH - 7.97), sandy to fine sandy loams. The soil had an electrical conductivity of 0.216 dSm^{-1}, low organic carbon (0.27%), medium levels of phosphorus (28.63 kg/ha), potassium (190 kg/ha) and sulphur (14.57 ppm). Micronutrients Zn, Fe and Mn are present in adequate amounts (3.46, 6.58 and 3.25 ppm, respectively). The cowpea variety Kashi Kanchan was used to assess the performance of various nutrient management strategies to identify the most effective management package. The experimental treatments comprised; T_1- RDF (100%) NPK through chemical fertilizers; T_2 - FYM @ 20 t/ha; T_3 - FYM @ 10 t/ha + RDF (50% - NPK through chemical fertilizers); T_4 - Neem cake @ 5 q/ha; T_5 - Neem cake @ 2.5 q/ha + RDF (50% - NPK through chemical fertilizers); T_6 - Vermicompost @ 5 t/ha; T_7 - Vermicompost @ 2.5 t/ha + RDF (50% - NPK through chemical fertilizers); T_8 - Poultry manure @ 5 t/ha; T_9 - Poultry manure @ 2.5 t/ha + RDF (50% - NPK through chemical fertilizers). The individual bed size was 3.0 × 3.0 m with 60 cm row to row and 20 cm plant to plant spacing arranged in randomized block design with three replications. The seeds were sown during first year on 2nd July and pods were harvested from 16th August to 23rd September, while in the second year seeds were sown on 14th July and pods were harvested from 21st August to 8th October. The growth, yield, yield attributing parameters and economical returns observations were made. In order to determine the degree of difference between all of the treatments and to achieve the results, an analysis of observations were made on various variables done by SPSS and analysis of variance.

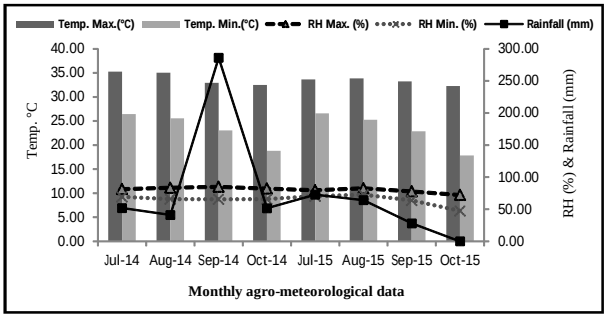

Fig. 1. Experimental location meteorological data of two years maximum and minimum temperatures (°C), rainfall (mm) and maximum and minimum relative humidity (%).

RESULTS AND DISCUSSION

The two years findings revealed that there were considerable variances in how integrated nutrient management affected plant growth and development showed significant and followed uniform trend for both years (Fig. 2). Among all the treatments of organic fertilizers and chemical fertilizers applied individually, the simultaneous application of poultry manure at 2.5 t/ha and 50% RDF through chemical fertilizers resulted maximum plant height of 69.43 cm and the number of branches per plant of 7.05, and the results were found statistically at par with the application of neem cake at 2.5 q/ha along with 50% RDF through chemical fertilizers. The interaction of treatment and year also influenced significantly on plant height and number of branches, the highest plant height (67.75 cm) was recorded in application of poultry manure at 2.5 t/ha and 50% RDF through chemical fertilizers

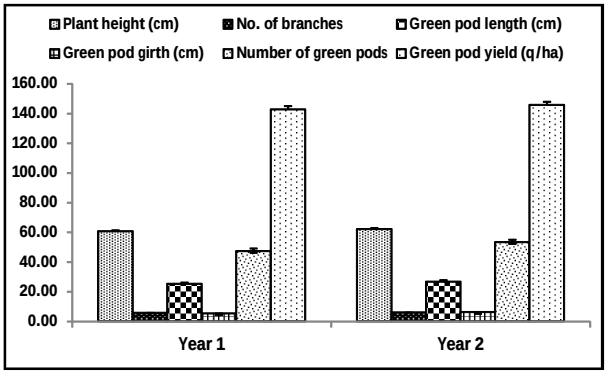

Fig. 2. Effect of integrated nutrient management on growth and yield attributes of cowpea during two years of the study.

during second year and the highest number of branches was recorded in application neem cake at 2.5 t/ha and 50% RDF through chemical fertilizers, where the plant height was found at par with application of neem cake at 2.5 t/ha and 50% RDF through chemical fertilizers and application of vermicompost at 2.5 t/ha and 50% RDF through chemical fertilizers. When the soil organic carbon content is low, the effectiveness of organic fertilizers can evaluated on plant growth and development and it can be used as indicator for the status of soil fertility. The alternative application of poultry manure and chemical fertilizers provides a balanced and comprehensive nutrient supply to the

TABLE 1
Effect of integrated nutrient management on crop growth and yield attributes of cowpea

Treatment	Plant height (cm)	No. of branches	Green pod length (cm)	Green pod girth (cm)	Number of green pods	Green pod yield (q/ha)
T_1–RDF - 100%	59.59	5.64	25.31	5.70	46.50	147.70
T_2–FYM @ 20 t/ha	56.41	5.36	25.34	5.66	42.17	128.24
T_3–FYM @ 10 t/ha + RDF 50%	58.68	5.50	23.15	5.61	47.17	130.36
T_4–Neem Cake @ 5 q/ha	60.80	5.45	25.91	5.68	45.83	133.78
T_5–Neem Cake @ 2.5 q/ha + RDF 50%	67.78	7.00	27.86	5.90	59.33	166.20
T_6–Vermicompost @ 5 t/ha	61.00	5.37	26.07	5.68	47.17	138.26
T_7–Vermicompost @ 2.5 t/ha + RDF 50%	58.65	5.53	25.81	5.72	52.67	137.78
T_8–Poulatary manure @ 5 t/ha	60.32	5.48	26.06	5.67	50.33	140.90
T_9–Poulatary manure @ 2.5 t/ha + RDF 50%	69.43	7.05	28.41	6.17	61.67	175.35
S.Em±	1.63	0.12	0.42	0.08	0.87	4.82
C. D. at 5%	3.31	0.25	0.85	0.17	1.77	9.82
Interaction (Treatment *Year)	**Plant height (cm)**	**No. of branches**	**Green pod length (cm)**	**Green pod girth (cm)**	**Number of green pods**	**Green pod yield (q/ha)**
T_1Y_1	48.29	5.22	24.08	5.13	44.83	140.56
T_1Y2	61.07	6.07	26.53	6.27	51.98	154.85
T_2Y_1	51.04	4.66	24.89	5.25	43.33	127.49
T_2Y_2	62.67	6.07	25.80	6.07	49.15	128.99
T_3Y_1	48.51	5.00	20.30	5.22	46.17	127.22
T_3Y_2	60.34	6.00	25.99	6.00	51.31	133.49
T_4Y_1	53.35	5.11	25.60	5.29	44.50	125.99
T_4Y_2	61.71	5.80	26.21	6.07	51.65	141.56
T_5Y_1	54.68	7.86	27.62	5.36	52.67	169.49
T_5Y_2	65.30	6.13	28.10	6.43	56.98	162.90
T_6Y_1	53.19	5.11	25.91	5.17	44.83	134.40
T_6Y_2	60.16	5.60	26.23	6.20	52.65	142.11
T_7Y_1	54.56	5.33	25.46	5.31	51.33	137.39
T_7Y_2	64.05	5.73	26.16	6.13	51.65	138.17
T_8Y_1	57.97	4.89	25.76	5.20	44.33	139.03
T_8Y_2	67.75	6.07	26.37	6.13	56.31	142.77
T_9Y_1	51.27	7.77	27.65	5.50	54.00	183.66
T_9Y_2	59.11	6.33	29.17	6.83	57.98	167.05
S.Em±	2.30	0.18	0.43	0.12	2.60	6.82
C. D. at 5%	4.69	0.36	0.87	0.24	5.30	13.89

growing plants, the poultry manure is rich in organic matter, rich in macro and, micro nutrients and chemical fertilizers also contain essential nutrients such as nitrogen, phosphorus and potassium (Ma *et al*. 2019; Adekiya *et al*. 2020). This optimum balanced fertilization application linked to strong root development, chlorophyll development, photosynthetic activity which enhances the carbohydrate translocation, likely played a significant role in enhances the development of strong cell walls and promoting optimal plant growth and development. Basnet *et al*. (2021) reported that application of balanced poultry manure and chemical fertilizer resulted maximum plant growth and development was noticed in radish. The sole application of FYM @ 20 t/ha recorded lowest plant height (56.41cm) and branches (5.36/plant) due to slow decomposition and release of nutrients results slow nutrient uptake by the crop.

The days to flower initiation was recorded between 34 to 36 days after seed sowing in all treatments and it was found that alternative application of organic and chemical fertilizers recorded early flowering in all the treatments combination, while the late flower initiation was recorded in sole application of farmyard manure. The data further revealed that there was a considerable impact of integrated nutrition management on the quantity of green pods produced by each plant. The longest green pods (28.41 cm), girth of green pods (6.17 cm), number of green pods per plant (60.92) and highest green pod yield (175.35 q/ha) were recorded in application of poultry manure at 2.5 t/ha along with 50% RDF through chemical fertilizers, the results were found at par with the application of neem cake at 2.5 q/ha along with 50% RDF through chemical fertilizers. The interaction of treatment and year significantly influenced on yield contributing parameters, the highest pod length, pod girth and number of green pods were recorded during second year and highest green pod yield was recorded during first year in application of poultry manure at 2.5 t/ha and 50% RDF through chemical fertilizers. The incorporation of organic manure contains macronutrients nitrogen, phosphorus and potassium may hasten the formation of amino acids and chlorophyll as well as improve the translocation of photosynthetic products from leaves to fruits (Ma *et al*. 2019; Adekiya *et al*. 2020). This, in turn, can lead to an increase in plant height, branches, pod length, pod girth, pod weight and number of pods per plant. Apart from this, poultry manure gradually releases nutrients to the growing plant over period of time throughout the cropping period. Thus optimum fertilizer dose resulted in higher yield attributing characteristics, which might be because alternative fertilizers application provides enough nutrients and absorbed by the plants more slowly, which increased the physio-morphological attributes (Alhrout *et al*. 2018). The use of integrated nutrients of poultry manure at 2.5 t/ha coupled with 50% RDF through chemical fertilizers in cowpea production clearly increased the yield as compared to only using organic and inorganic fertilizers individual. On the other hand, FYM alone showed the lowest size and number of pods which results poor yield (127.49 q/ha). This is probably due to insufficient nutrient availability to the plants at the earlier stages and later stages of the crop. Therefore the combination of organic fertilizers with chemical fertilizers helped reducing nutrient loss and improving nutrient utilization resulting better pod yield.

Perusal of the data from Table 2 revealed that total expenditure, maximum gross returns, net returns and BC ratio (¹ 99852/ha, ¹ 200460/ha, ¹ 100608/ha and 2.00, respectively) were found in application of poultry manure at 2.5 t/ha along with 50% RDF through chemical fertilizers, whereas in RDF - 100%

TABLE 2
Economics of cowpea as influenced by integrated nutrient management

Treatment	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	BC ratio
T_1–RDF - 100%	97924	185820	87896	1.89
T_2–FYM @ 20 t/ha	99780	154788	55008	1.55
T_3–FYM @ 10 t/ha + RDF 50%	98852	160188	61336	1.62
T_4–Neem Cake @ 5 q/ha	117500	169872	52372	1.44
T_5–Neem Cake @ 2.5 q/ha + RDF 50%	108352	195480	87128	1.80
T_6–Vermicompost @ 5 t/ha	118780	170520	51740	1.43
T_7–Vermicompost @ 2.5 t/ha + RDF 50%	108352	165804	57452	1.53
T_8–Poultry manure @ 5 t/ha	101780	171312	69532	1.68
T_9–Poultry manure @ 2.5 t/ha + RDF 50%	99852	200460	100608	2.00

recorded minimum cost of cultivation (Rs. 97924/ha) due to lower prices of chemical fertilizers recorded better gross as well as net returns and BC ratio (Rs. 185820/ha, 87896/ha and 1.89, respectively). The rest of the organic treatments fetch higher cost of input as compare to chemical fertilizers resulted lower BC ratio obtained. The highest cost of cultivation was noticed in application of vermicompost at 5 t/ha (Rs. 118780) which causes the lowest BC ratio (1.43). The application of poultry manure at 2.5 t/ha along with 50% RDF through chemical fertilizers is the most appropriate combination among various nutrient sources to obtain higher pod yield and yield contributing characters of cowpea like size of pod, number of pods along with higher net returns of cowpea.

CONCLUSION

Integrated nutrient management study was conducted on cowpea for two years proved that integrated nutrient management of organic and chemical fertilizer combination is better for soil health, safety and higher production. The treatment soil application of poultry manure at 2.5 t/ha and in combination with 50% RDF through chemical fertilizers proved to be the best during both years in terms of increased plant growth, yield attributes and yield of cowpea Similarly, maximum gross as well as net returns along with highest BC ratio was also obtained in the same treatment. As a result, it can be advised for the profitable production of cowpea and beneficial for the physical and chemical characteristics of the soil.

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