

## EFFECTS OF ORGANIC FORMULATIONS AND SYNTHETIC FERTILIZER ON THE PERFORMANCE OF PIGEONPEA IN EASTERN REGION OF UTTAR PRADESH

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### Abstract

A field experiment involving five organic formulations *viz.*, cow urine, vermiwash, neem seed extract, fish wash normal water (control) and three levels of NPK *viz.*, 50% recommended dose of fertilizer (RDF), 75% RDF and 100% RDF with total 15 treatment combinations in randomized complete block design with three replications was conducted at Varanasi during *Kharif* season (July-April) 2014-15 to evaluate the effect of different organic formulations and NPK fertilization on pigeonpea. Results showed that increasing level of NPK up to 100% RDF significantly improved growth parameters, yield attributes, grain and straw yield. Among the treatment combinations, combined application of 100% RDF + vermiwash proved superior over other treatments, these recorded the highest growth yield attributes, gross returns, and net returns while B : C ratio was the highest under 100% RDF in combination with cow urine.

### Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is the fifth prominent pulse crop in the world and in India after chickpea. It is one of the most important *Kharif* pulses suitable for rainfed situation with an area of 4.06 m ha (15.5%), production 3.2 mt (18.6%) and productivity 902 kg/ha in the country (IIPR 2015). Uttar Pradesh is the second leading state after Maharashtra covering 0.29 m ha of area and, 0.26 mt production with the productivity 902 kg/ha (IIPR 2015). Eastern UP has a major area of pigeonpea (long duration) under rainfed condition. It can be grown as a sole as well as intercropped with short duration legume as well as cereals. Eventually, an adequate fertilizer management appreciable for higher yield is needed to be worked out. However, the productivity of pigeonpea is now slowing down coupled with decline in soil fertility. Low and imbalanced use of fertilizers is one of the major reasons for low productivity. It has been recognized that N, P and K fertilizers alone are not always sufficient to provide balanced nutrition for optimal yield and quality of pigeonpea (Jain *et al.* 2007).

The escalating price of fertilizers in recent years, limit their use in crop production. Therefore, the nutrient application through chemical fertilizers, if supplemented with low cost organic sources will not only economize the nutrient use but also improve the soil health and factor productivity on sustainable basis. Crop and dairy is the predominant farming system in the country practiced by over 70% farm households. The abundant quantity of cattle excreta consisting of dung and urine has a good manurial value and can be utilized as a bio fertilizer (Khanal *et al.* 2011). Cattle urine is a good source of nitrogen, phosphate, potassium, calcium, magnesium, chlorite sulphate and plant hormone.

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Vermiwash obtained from dissolution of organic matter by earthworm was also found as a good liquid manure and had significant effect on crop growth and productivity (Subasasri 2003) and reported to increase disease resistant power of crop (Yadav *et al.* 2005).

Neem seed extract performs the dual function of both fertilizer and pesticide of organic origin. It also acts as a soil enricher and provides essential nutrients for plant growth. It is bio-degradable, eco-friendly and excellent soil conditioner which help to increase the crop yield on long run (Lokanadhan *et al.* 2012).

Fermented fish waste is found to enrich the soil nutrients required for plant growth and favourably influences the conducting functions of xylem and phloem vessels. Thus fish waste could also be used as a valuable organic liquid fertilizer for better yield of crops at a lesser cost and without any harmful effects on soil environment (Balraj *et al.* 2014). Despite available information, as mentioned above, on the beneficial effect of organic compound on the productivity of crops, scarce reports are available on interactive effects of organic formulations and NPK on the performance of pigeonpea. This field experiment was therefore, undertaken to assess the response of pigeonpea to organic formulations along with different levels of synthetic fertilizers in the eastern region of Uttar Pradesh of India.

### Materials and Methods

A field experiment was carried out during *kharif* season of 2014 at Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh of India to study the effect of organic formulations along with synthetic fertilizer (NPK) on the performance of pigeonpea. The soil of the experimental field was sandy clay loam in texture, with soil pH 7.6, low in organic carbon (0.33%), medium in available nitrogen (189.80 kg/ha), low in available  $P_2O_5$  (19.5 kg/ha) and medium in available  $K_2O$  (200.30 kg/ha). Experiment was laid out in a randomized complete block design with fifteen treatment combinations *viz.* 50% recommended dose of fertilizer (RDF) + normal water @1000 l/ha (T<sub>1</sub>), 50% RDF + neem seed extract @100 l/ha (T<sub>2</sub>), 50% RDF + vermiwash @100 l/ha (T<sub>3</sub>), 50% RDF + fish wash @100 l/ha (T<sub>4</sub>), 50% RDF + cow Urine @100 l/ha (T<sub>5</sub>), 75% RDF + normal water @1000 l/ha (T<sub>6</sub>), 75% RDF + neem seed extract @100 l/ha (T<sub>7</sub>), 75% RDF + vermiwash @100 l/ha (T<sub>8</sub>), 75% RDF + fish wash @100 l/ha (T<sub>9</sub>), 75% RDF + cow urine @100 l/ha (T<sub>10</sub>), 100% RDF + normal water @1000 l/ha (T<sub>11</sub>), 100% RDF + neem seed extract @100 l/ha (T<sub>12</sub>), 100% RDF + vermiwash @100 l/ha (T<sub>13</sub>), 100% RDF + fish wash @100 l/ha (T<sub>14</sub>) and 100% RDF + cow urine @100 l/ha (T<sub>15</sub>) replicated thrice. Recommended dose of fertilizer (RDF) for Varanasi region N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O (30-60-20 kg/ha) was used to raise the experimental crop. Full recommended dose of NPK was applied as basal in the furrow at sowing. The sources of fertilizers for NPK were urea (46% N), SSP (16% P<sub>2</sub>O<sub>5</sub>, 12% S) and muriate of potash (60% K<sub>2</sub>O). Whereas, application of organic formulations i.e. cow urine, vermiwash, neem seed extract and fish wash @ 100 litre in 1000 litre of normal water/ha at 50, 100, 150 day was done after sowing. Pigeonpea crop variety 'Malaviya Chamatkar (Malaviya-13)' was raised with seed rate of 15.0 kg/ha at a spacing of 60 cm × 25 cm. Chemical weed control was carried out by application of pendimethalin @1 kg a.i /ha as pre emergence spray which was accompanied by one mechanical-cum-manual weeding at 4 week stage of the crop. Throughout the crop period, experimental crop received 647 mm rainfall of which 266.1 mm in July, 251.6 mm in August, 61.7mm in September, 56.9 mm in October, 6.7 mm in January, 1.6mm in February, 1.1 mm in March, and 1 mm occur in April. The data recorded were analyzed following standard statistical procedure to draw a valid conclusion.

## Results and Discussion

*Growth parameters:* Among the different combinations of fertilizer and organic formulations the treatment, 100% RDF + vermiwash @100 l/ha showed the highest plant height, number of primary branches, number of secondary branches, leaf area index and dry matter accumulation as compared to the other treatments, such as 100% RDF + neem seed extract @100 l/ha, 100% RDF + fish wash @100 l/ha, 100% RDF + normal water @1000 l/ha, 75% RDF + vermiwash @100 l/ha, 75% RDF + cow urine @100 l/ha, 75% RDF + neem seed extract @100 l/ha, 75% RDF + fish wash @100 l/ha, 75% RDF + normal water @1000 l/ha, 50% RDF + vermiwash @100 l/ha, 50% RDF + cow urine @100 l/ha, 50% RDF + neem seed extract @100 l/ha, 50% RDF + fish wash @100 l/ha and 50% RDF + normal water @1000 l/ha, respectively, though the result was at par with the treatment of 100% RDF + cow urine @ 100 l/ha (Table 1). The similar results were also reported by Rekha *et al.* (2013), Sahay *et al.* (2016) and Tiwari and Singh (2016). This is the fact that the combined application of nitrogen, phosphorus, potassium and vermiwash in adequate quantity was beneficial for growth and development of crop as reported by Singh *et al.* (2015).

**Table 1. Effect of organic formulations and NPK levels on growth and yield attributes of pigeonpea.**

| Treatment                              | Plant height | No. of primary branches | No. of secondary branches | LAI   | Dry matter | Pods/plant | Grain/pods | Test weight (g) |
|--|--------------|-------------------------|---------------------------|-------|------------|------------|------------|-----------------|
| 50% RDF + normal water @1000 l/ha      | 204.23       | 16.77                   | 15.53                     | 2.02  | 188.89     | 125.14     | 3.58       | 95.00           |
| 50% RDF + neem seed extract @100 l/ha  | 210.41       | 17.12                   | 15.81                     | 2.06  | 193.28     | 128.18     | 3.68       | 96.97           |
| 50% RDF + vermiwash @100 l/ha          | 213.23       | 17.55                   | 16.21                     | 2.11  | 197.69     | 130.97     | 3.75       | 99.43           |
| 50% RDF + fish wash @100 l/ha          | 205.80       | 16.88                   | 15.63                     | 2.04  | 190.69     | 126.33     | 3.62       | 95.91           |
| 50% RDF + cow urine @100 l/ha          | 212.74       | 17.44                   | 16.13                     | 2.10  | 196.72     | 130.22     | 3.73       | 98.99           |
| 75% RDF + normal water @1000 l/ha      | 214.21       | 17.59                   | 16.29                     | 2.11  | 198.12     | 131.26     | 3.76       | 99.65           |
| 75% RDF + neem seed extract @100 l/ha  | 222.38       | 18.13                   | 16.74                     | 2.18  | 203.68     | 134.59     | 3.88       | 102.72          |
| 75% RDF + vermiwash @100 l/ha          | 224.69       | 18.41                   | 17.00                     | 2.22  | 207.39     | 137.40     | 3.94       | 104.31          |
| 75% RDF + fish wash @100 l/ha          | 216.11       | 17.90                   | 16.45                     | 2.15  | 201.56     | 132.78     | 3.82       | 101.38          |
| 75% RDF + cow urine @100 l/ha          | 224.01       | 18.33                   | 16.93                     | 2.20  | 206.13     | 136.73     | 3.92       | 103.89          |
| 100% RDF + normal water @1000 l/ha     | 226.10       | 18.57                   | 17.14                     | 2.23  | 209.12     | 138.54     | 3.97       | 105.18          |
| 100% RDF + neem seed extract @100 l/ha | 229.08       | 18.78                   | 17.40                     | 2.27  | 212.25     | 140.49     | 4.02       | 106.77          |
| 100% RDF + vermiwash @100 l/ha         | 232.14       | 19.07                   | 17.61                     | 2.29  | 214.83     | 142.33     | 4.09       | 108.05          |
| 100% RDF + fish wash @100 l/ha         | 226.90       | 18.63                   | 17.24                     | 2.24  | 209.86     | 139.04     | 3.98       | 105.55          |
| 100% RDF + cow urine @100 l/ha         | 231.64       | 18.97                   | 17.57                     | 2.29  | 214.09     | 141.83     | 4.07       | 107.52          |
| SEm +                                  | 0.43         | 0.04                    | 0.03                      | 0.005 | 0.41       | 0.36       | 0.01       | 0.24            |
| CD (p = 0.05)                          | 1.26         | 0.12                    | 0.10                      | 0.015 | 1.19       | 1.05       | 0.03       | 0.71            |

*Effect of on yield attributes:* Among the different treatment combinations the treatment, 100% RDF + vermiwash @100 l/ha had significantly the highest pods/plant, grains/pod and the test weight as compared to 100% RDF + neem seed extract @100 l/ha, 100% RDF + fish wash @100 l/ha, 100% RDF + normal water @1000 l/ha, 75% RDF + vermi wash @100 l/ha, 75% RDF + cow urine @100 l/ha, 75% RDF + neem seed extract @100 l/ha, 75% RDF + fish wash @100 l/ha, 75% RDF + normal water @1000 l/ha, 50% RDF + vermiwash @100 l/ha, 50% RDF + cow urine @100 l/ha, 50% RDF + neem seed extract @100 l/ha and 50% RDF + fish wash @100 l/ha (95.91 g), respectively though that was statistically at par with the treatment 100% RDF + cow urine @100 l/ha (107.52 g) (Table 1). The results are corroborated with the research finding of Sharma *et al.* (2010) and Singh (2007).

**Table 2. Effect of organic formulations and NPK levels on yield and economics of pigeonpea.**

| Treatment                              | Grain yield (kg/ha) | Stalk yield (kg/ha) | Harvest index (%) | Cost of cultivation (₹/ha) | Gross returns (₹/ha) | Net returns (₹/ha) | B:C ratio |
|--|---------------------|---------------------|-------------------|----------------------------|----------------------|--------------------|-----------|
| 50% RDF + normal water @1000 l/ha      | 1259                | 5725                | 18.03             | 29467                      | 86990                | 57523              | 1.95      |
| 50% RDF + neem seed extract @100 l/ha  | 1349                | 5924                | 18.55             | 30267                      | 92789                | 62522              | 2.07      |
| 50% RDF + vermiwash @100 l/ha          | 1413                | 6160                | 18.66             | 30667                      | 97100                | 66433              | 2.17      |
| 50% RDF + fish wash @100 l/ha          | 1298                | 5860                | 18.14             | 29867                      | 89621                | 59754              | 2.00      |
| 50% RDF + cow urine @100 l/ha          | 1396                | 6145                | 18.52             | 30267                      | 96069                | 65802              | 2.17      |
| 75% RDF + normal water @1000 l/ha      | 1447                | 6157                | 19.03             | 30273                      | 99155                | 68882              | 2.28      |
| 75% RDF + neem seed extract @100 l/ha  | 1535                | 6429                | 19.28             | 31073                      | 104997               | 73924              | 2.38      |
| 75% RDF + vermiwash @100 l/ha          | 1611                | 6681                | 19.43             | 31473                      | 110062               | 78589              | 2.50      |
| 75% RDF + fish wash @100 l/ha          | 1488                | 6280                | 19.16             | 30673                      | 101860               | 71187              | 2.32      |
| 75% RDF + cow urine @100 l/ha          | 1592                | 6638                | 19.35             | 31073                      | 108835               | 77762              | 2.50      |
| 100% RDF + normal water @1000 l/ha     | 1641                | 6763                | 19.53             | 31099                      | 112026               | 80927              | 2.60      |
| 100% RDF + neem seed extract @100 l/ha | 1727                | 6927                | 19.96             | 31899                      | 117494               | 85595              | 2.68      |
| 100% RDF + vermiwash @100 l/ha         | 1810                | 7007                | 20.53             | 32299                      | 122654               | 90355              | 2.80      |
| 100% RDF + fish wash @100 l/ha         | 1685                | 6828                | 19.79             | 31499                      | 114757               | 83258              | 2.64      |
| 100% RDF + cow urine @100 l/ha         | 1792                | 6991                | 20.40             | 31899                      | 121503               | 89604              | 2.81      |
| SEm+                                   | 12                  | 18.1                | 0.11              | -                          | 741                  | 741                | 0.024     |
| CD(p = 0.05)                           | 34.8                | 52.4                | 0.31              | -                          | 2147                 | 2147               | 0.070     |

*Yield:* Pigeonpea with with 100% RDF + vermiwash @100 l/ha showed significantly the highest pods/plant (142.33), grains/pod (4.09) and the test weight (108.05) which resulted the highest grain and stalk yield as compared to the treatments of 100% RDF + neem seed extract @100 l/ha, 100% RDF + fish wash @100 l/ha, 100% RDF + normal water @1000 l/ha, 75% RDF + vermiwash @100 l/ha, 75% RDF + cow urine @100 l/ha, 75% RDF + neem seed extract @100 l/ha, 75% RDF + fish wash @100 l/ha, 75% RDF + normal water @1000 l/ha, 50% RDF + vermiwash @100 l/ha, 50% RDF + cow urine @100 l/ha, 50% RDF + neem seed extract @100 l/ha and 50% RDF + fish wash @100 l/ha (1298 kg/ha), respectively and that was statistically at par with 100% RDF + cow urine @100 l/ha (Table 2). The positive response of pigeonpea to applied nutrients and organic formulations was also reported by Rekha *et al.* (2013), Singh *et al.* (2014), and Nath and Singh (2016).

*Economics:* Data clearly indicated that gross returns, net returns and B : C ratio enhanced significantly with each increment of fertility level and organic formulations and that recorded the highest with the application of 100% RDF + vermiwash @100 l/ha followed by that with 100%

RDF + cow urine @100 l/ha 100% RDF + neem seed extract @100 l/ha 100% RDF + fish wash @100 l/ha 100% RDF + normal water @1000 l/ha 75% RDF + vermiwash @100 l/ha 75% RDF + cow urine @100 l/ha 75% RDF + neem seed extract @100 l/ha 75% RDF + fish wash @100 l/ha 75% RDF + normal water @1000 l/ha 50% RDF + vermiwash @100 l/ha 50% RDF + cow urine @100 l/ha 50% RDF + neem seed extract @100 l/ha and 50% RDF + fish wash @100 l/ha, respectively. The similar results were also reported by Kumbhar *et al.* (2015).

From the results it may be concluded that, application of 100% RDF along with vermiwash @100 l/ha in pigeonpea greatly enhanced the growth parameters, yield attributes, yield, and economics followed by the same with 100% RDF along with cow urine @ 100 l/ha compared to other combinations.

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