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# Effect of 2:2 ratio planting on conservation tillage with nutrient management on pigeon pea

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## Abstract
The faulty agricultural practices create the problem likes degradation of natural resources, only one way to out come these problem uses the conservation agriculture practices. The slow growth of pigeon pea during initial phase of growth that minimizes competition in intercropping systems that create pigeon pea well-suited with most cereal-based systems. This experiment was conducted at TCA research farm, Dholi (Dr. RPCAU, Pusa) during 2019-2020. To find out the effect on permanent bed and zero tillage practices on pigeon pea in maize-pigeon pea intercropping system. The experiment was led out in split plot design with 4 main plot treatments *viz.*, $T_1$: Permanent bed (PB), $T_2$: Zero tillage (ZT), $T_3$: Fresh bed (FB) and $T_4$: Conventional tillage (CT) and 3 sub-plot treatments *viz.*, $N_1$: 100% Recommended dose of fertilizer (RDF), $N_2$: 120% Recommended dose of fertilizer (RDF) and $N_3$: 80% Recommended dose of fertilizer (RDF) which were replicated thrice. The result indicated that the parameters of growth, yield attributes and yield of pigeon pea affected by tillage and nutrient management. The plant height, primary and secondary branches of pigeon pea were significant influenced by tillage and nutrient management and it were higher in PB and 120% RDF application and it at par with ZT and 100% RDF application which were compared to CT and 80% RDF application. The higher growth under these treatments were also associated with yield attributing character of pigeon pea *viz.*, number of pods per plant, number of grains per pod and test weight. Pigeon pea was recorded higher grain yield with PB (21.8 q/ha) remained superior to its yields under ZT (19.5 q/ha) FB (18.2 q/ha) and CT (18.0 q/ha) practices while, under the nutrient management practices recorded highest yield with 120% RDF application in pigeon pea (21.1 q/ha) which was over the 100% RDF application in both crops. Harvest index of both crops were higher in PB and 120% RDF applications which was closely followed by ZT and 100% RDF application.

**Keywords:** Conservation tillage, fresh bed, intercropping system, nutrient management, permanent bed, zero tillage

## Introduction
Pigeon pea (*Cajanus cajan* L.) is grown in semi-arid regions of Africa and Asia, In India it is grown-up as a tropical grain legume crop and ranks first in area and production and share about 63% total production (FAOSTAT 2013) [7]. In India, pigeon pea is grown in 4.43 M ha of area with the 4.25 MT of production and 960 kg $ha^{-1}$ of productivity, In Bihar, area of pigeon pea 21.99 thousand ha with production 35.03 lakh tonnes and the highest productivity in India 1593 kg $ha^{-1}$ ($4^{th}$ advance estimate, Directorate of Economics & Statistics, 2018-19) [14]. Pigeon pea is an edible legume and also capable of fixing atmospheric nitrogen in association with rhizobium bacteria and provides organic matter. Its grain is a good source of dietary protein (21.7%) for the food and feed while the dry stems make good fuel wood. Pigeon pea plants have decreased the interspecific competition in mixed culture because it has both physiological and morphological characteristics. The slow growth of pigeon pea during initial phase of growth that minimizes competition in intercropping systems that create pigeon pea well-suited with most cereal-based systems. Intercropping means of hastening crop production and maximum return from small land holdings with effective utilization of resources. The accomplishment of an intercropping system based on the right supervision of resources with stable usage of manures and fertilizers. Increasing productivity through adequate utilization of available natural resources, e.g. Light and nutrients are possible through intercropping, the demand for component crops is well understood (Midmore, 1993) [17]. Maize with pigeon pea intercropping is well opportunity since pigeon pea is a grain legume drought tolerant crop that help in nitrogen fixation in soil and also its deep-rooted system brings up minerals from lower horizons that not taken by other cereals crop. Pigeon pea also able to rise the accessibility of soluble iron-bound P to maize and provide energy in biological nitrogen fixation.

Pigeon pea augments organic matter in considerable quantity (Egbe, 2005) [15] and fix up to 235 kg ha$^{-1}$ N in soil because its biomass has high N content than many other legumes. The inclusion of pigeon pea crop in rural areas will create additional protein-rich food on the menu that can help to ease starvation and under nourishment (Yeboah *et al*., 2004) [18]. Currently this experiment was carried out to found the conservation tillage practice and nutrient management for yield maximization of pigeon pea in emerging cropping system (maize + pigeon pea).

## Material and Method

A field experiment was carried out during the summer (*kharif*) seasons of 2019-20 at research farm field in TCA, Dholi, under Dr.RPCAU, Pusa, Samastipur (Bihar). The experiment was executed in split plot design with three replications having net plot size of 8.44 m x 4.20 m. the main plot treatment was tillage practices likes, 1) Zero tillage (ZT), 2) Permanent bed (PB), 3) Fresh bed (FB) and 4) Conventional tillage (CT) and in sub plot treatment was nutrient management likes, 1) 100% RDF, 2) 120% RDF and 3) 80% RDF led in split plot design. Both crops were sown in the 3rd week of June with 2:2 ratio row 67/20 cm apart and plant to plant distance of 20 cm were maintained by thinning at 15 days after sowing. The recommended dose of fertilizers of pigeon pea (30:50:30 NPK Kg/ha) was given according to the treatment. Full dose nitrogen, phosphorous and potassium in pigeon pea were applied at the time of sowing according to the treatment in each plot. One hand weeding was done at 30 days of sowing. The data of growth parameters, yield attributes and yields of pigeon pea recorded at different stage of growth and analysed as per standard by statistical method (Gomez and Gomez, 1984) [19].

## Result and Discussion

### Growth parameters

In growth parameter *viz.*, the plant height, plant population and no. of primary branches plant$^{-1}$ and no. of secondary branches plant$^{-1}$ varies differentially with different tillage and nutrient management treatments. Tillage and nutrient management practices significantly affected the plant height at harvest while, at 25 DAS plant height did not affect by these treatments. Permanent bed showed significantly superior plant height at harvest which was at par with zero tillage over the fresh bed and conventional tillage. Highest plants height was observed in permanent bed (PB) at harvest with values of 270.0 cm compared to FB (258.9 cm) and CT (257.4 cm), however at 25 DAS PB has higher plant height 23.6 cm *fb* ZT (22.6 cm), FB (22.3 cm) and CT (21.8 cm).

The result showed that the growth parameters *viz.*, no. of primary branches plant$^{-1}$, no. of secondary branches plant$^{-1}$ and plant height at harvest significantly higher were noticed under PB and ZT than FB and CT while, plant height at 25 DAS and plant population were not affected by tillage practices (Table 1). Plant population indicating uniformity in plant population in all treatment. PB and ZT higher Primary and Secondary branches which were due to higher availability of moisture, reduce water logging condition, good physical condition of soil, high root proliferation (Mishra *et al*., 2014) [4, 20], moisture conservation in stress condition, drainage of excess water during rainfall and optimum nutrient availability therefore minimum tillage recorded best plant growth (Singh *et al*., 2010) [8, 21].

Among the nutrient management practices, RDF 120% recorded significantly higher plant height at harvest (271.2 cm) as compared to 100% RDF (264.3 cm) and 80% RDF (255.0 cm) however at 25 DAS 120% RDF higher plant height (23.2 cm) *fb* 100% RDF (22.5 cm) and 80% RDF (22.1 cm) respectively (Table 1).

Across the treatments plant population showed no significant difference among tillage and nutrient management practices either in initial (or) final stage. However, in initial stage under permanent bed (PB) maximum plant population (56939) was noticed followed by ZT (56710), FB (57134) and CT (57028). Similarly, the plant population at final stage also presented no significant alteration between the tillage and nutrient management practice. However, maximum plant population was observed in PB (53762) followed by ZT (53664), FB (53464) and CT (53396). Like tillage practice, nutrient management also showed no significant difference among the treatments. No. of primary branches plant$^{-1}$ and No. of secondary branches plant$^{-1}$ showed significant difference across the treatments in both tillage and nutrient management treatments. In tillage practice, higher no. of primary branches plant$^{-1}$ and no. of secondary branches plant$^{-1}$ was noticed in PB (8.8 and 11.8) which was at par with ZT (7.9 and 11.6) over by FB (6.5 and 10.2) and CT (5.7 and 9.4). Similarly, in nutrient management, higher no. of primary branches plant$^{-1}$ and no. of secondary branches plant$^{-1}$ were observed in RDF 120% (8.4 and 11.7) at par with 100% RDF (7.47 and 10.9) over 80% RDF (5.6 and 9.5) respectively.

In the nutrient management system significantly affect the growth parameters *viz.*, plant height at harvest, no. of primary branches plant$^{-1}$ and no. of secondary branches plant$^{-1}$. Nutrient management system 120% RDF and 100% RDF treatment resulted that over the 80% RDF treatment. This is due to favourable and easily availability of optimum supply nutrient. Enhanced rate of nutrients accelerates the translocation potential of photosynthates from sink to source which is more related with area of leaf. Nitrogen being a part of proteins, enzymes and chlorophyll similarly phosphorus being the constituent of phosphor-nucleotides promotes the cell division and enlargement might have helped to achieve higher plant height. (Jat and Ahlawat, 2001 and Babu *et al.*, 2014) [3, 1] also found similar findings.

### Yield attribute

Yield assigning characters *viz.*, days to 50% flowering, days to maturity, length of pod, no. pod plant$^{-1}$, no. of grains pod$^{-1}$ and test weight are presented in Table 2. Days to 50% flowering and days to maturity did not affect by different tillage practices. However, in case of days to 50% flowering PB and ZT showed earliness ac compared to FB and CT. Whereas, in days to maturity CT advanced by one day over ZT and PB respectively. Similarly, nutrient management practice did not affect days to 50% flowering and days to maturity. However, 80% RDF nutrient management showed reduced days to 50% flowering and maturity compared to 100% RDF and 120% RDF.

Yield attributes were significantly affected by tillage practices *viz*., no. of pods plant$^{-1}$, no. of grains pod$^{-1}$ and test weight in PB and ZT over the FB and CT. PB and ZT increased the no. of pods plant$^{-1}$, no. of grains pod$^{-1}$ and test weight compared to FB and CT (Table 2). In PB and ZT was mainly due to a greater no. of branches, plant height and higher dry biomass production as related to FB and CT. As earlier stage of pigeon pea the growth was slow than the maize, after harvesting of maize, pigeon pea done higher photosynthesis and better utilization of radiant energy that increase higher sink and source capacity. In PB and ZT enhance in situ moisture conservation, favourable microclimate which increases the availability of optimum supply of nutrient and avoidance of waterlogging were the principal reasons for better performance, that encourage crop growth and yield attributes (Krishnaprabu, 2019) [6]. Pigeon pea also, the leaf litter fall was more in life cycle that was enhance the organic matter and nutrient status of soil, increase the infiltration of water. Due to conservative tillage practices, enhance the organic matter, improve the soil health, better soil climate for beneficial micro-organism that enhance mineralization, root nodules activity and $N_2$ fixation process that led to favourable for enhancing the yield attributes (Jat *et al.*, 2011 and Singh *et al.*, 2018) [5, 7] also confirmed the same results.

The length of pod, no. of grains pod$^{-1}$, no. of pods plant$^{-1}$ and 100 grains test weight were significantly influenced by tillage and nutrient management practices. In tillage practices, length of pod was higher in PB (5.9 cm) which was statistically at par with ZT (5.6 cm) over FB (5.2 cm) and CT (4.5 cm). Among the nutrient management treatments 120% RDF (5.6 cm) observed maximum length of cob and at par with 100% RDF (5.5 cm) as compared to 80% RDF (5.1 cm). Among the tillage practices, no. of grains pod$^{-1}$ and no. of pods plant$^{-1}$ were higher in PB (180.5 and 4.1) which was statistically at par with ZT (175.2 and 4.0) as compared to FB (166.7 and 3.5) and CT (163.0 and 3.4). Similarly, in nutrient management 120% RDF found highest no. of grains pod$^{-1}$ and no. of pods plant$^{-1}$ (176.6 and 4.0) were found at par with 100% RDF (172.6 and 3.9) followed by 80% RDF (164.9 and 3.5) treatment. 100 seed test weight (seed index) was affected by different tillage and nutrient management treatment, maximum test weight was observed with PB (11.3 g) and 120% RDF (11.1 g) at par with ZT (11.2 g), 100% RDF (10.7 g) followed by FB (10.3 g), CT (9.8 g), 80% RDF (10.1 g).

The nutrient management treatment significantly affected that the yield attribute *viz.*, no. of grains pod$^{-1}$, no. of pods plant$^{-1}$ and test weight. The treatment 120% RDF and 100% RDF treatment showed significantly affected yield attribute over the 80% RDF treatment. Theno. of grains pod$^{-1}$, no. of pods plant$^{-1}$and test weight was enhanced in 120% RDF and 100% RDF treatment compared to 80% RDF treatment. This is mainly due to better nutrition to plant led to effectual and better apportioning of metabolites and more translocation of photosynthates and nutrients to the develop reproductive structure efficiently and also conservative tillage increase the availability of nutrient and reduce the losses due to leaching and other losses, that possess improved the availability of nutrients resulting in positive effect in yield attributes.

### Crop yields

The grain yield and biological yield of pigeon pea statistically differed with both tillage and nutrient management practices (Table 3). Across tillage practices the grain and biological yield in PB (21.8 and 79.3 q ha$^{-1}$) which was higher from ZT (19.5 and 75.2 q ha$^{-1}$), FB (18.2 and 73.9 q ha$^{-1}$) and CT (18.0 and 70.1 q ha$^{-1}$). Under nutrient management, 120% RDF significantly differed the grain and biological yield (21.1 and 79.5 q ha$^{-1}$) over the 100% RDF (19.2 and 74.2 q ha$^{-1}$) and 80% RDF (17.8 and 70.2 q ha$^{-1}$). Straw yield did not affect by different tillage and nutrient management practices. However higher straw yields were found in PB (57.51 q/ha) *fb* ZT (55.7 q/ha) FB (55.6 q/ha) and CT (53.3 q/ha) and Similarly, harvest index (HI) was no significantly difference in PB (27.5%), ZT (26.1%), FB (24.8%) and CT (25.7%).

The results indicated that PB gave more seed yield and stalk yield over to ZT, FB and CT. The seed yield and stalk yield in PB increased was nearly about 20.85, 19.59, 11.58 and 10.36, 3.31, 3.18% respectively, over CT, FB and ZT (Table 3). The reason behind yield increases in PB and ZT was significant augmented in no. of pods plant$^{-1}$, no. of grains pod$^{-1}$ and test weight as compared to FB and CT. This augmentation in yield due to enhancement in soil nutritional status, organic matter, physical condition and higher soil moisture availability for crop during the growth that enhanced the nutrient availability, which have replicated in more growth of yield attributes that is lead to higher seed yield (Singh *et al.*, 2010) [8, 21]. (Singh *et al.*,2018, Dhindwal *et al.*, 2006, Jat and Ahlawat, 2001, Desai *et al.*, 2000 and Sayre, 2000) [7, 10, 3, 9, 13] also reported the same results.

Nutrient management treatment affected significantly the grain yield and stalk yield of pigeon pea. 120% RDF and 100% RDF treatment significantly over the 80% RDF treatment in the view of grain and stalk yield. This increment was 18.83, 8.19 and 11.44, 4.80% over the 80% RDF. it might be due to rapid mineralization and steady supplying of nutrient to crop, better utilization of nutrient due to conservative tillage practices resulted in profuse root and shoot growth, and thereby it activates the greater absorption of these nutrients lead to improved yield attributes *viz.*, test weight, no. of grains pod$^{-1}$ and no. of pods plant$^{-1}$ that increases grain yield under the 120% RDF and 100% RDF treatment. (Honnali *et al.*, 2020, Kumawat *et al.*, 2013 and Pandey *et al.*, 2013) [2, 11, 13] also same resulted reported.

**Table 1:** Growth of pigeon pea crop affected by tillage and nutrient management practices.

| Treatments | Plant population ha$^{-1}$ | | Plant height (cm) | | Primary branches / plant | Secondary branches / plant |
|---|---|---|---|---|---|---|
| | 25 DAS | At harvest | 25 DAS | At harvest | | |
| **Tillage practices** | | | | | | |
| Zero Tillage | 56710 | 53664 | 22.6 | 267.8 | 7.9 | 11.6 |
| Permanent Bed | 56939 | 53762 | 23.6 | 270.0 | 8.8 | 11.8 |
| Fresh Bed | 57134 | 53464 | 22.3 | 258.9 | 6.5 | 10.2 |
| Conventional tillage | 57028 | 53396 | 21.8 | 257.4 | 5.7 | 9.4 |
| S.Em± | 487.49 | 375.08 | 0.54 | 1.92 | 0.42 | 0.34 |
| LSD (p =0.05) | NS | NS | NS | 6.7 | 1.5 | 1.2 |
| **Nutrient management** | | | | | | |
| 100% RDF | 57496 | 53454 | 22.5 | 264.3 | 7.5 | 10.9 |
| 120% RDF | 56679 | 53825 | 23.2 | 271.2 | 8.4 | 11.7 |
| 80%RDF | 56683 | 53435 | 22.1 | 255.0 | 5.6 | 9.5 |
| S.Em± | 370.06 | 196.26 | 0.31 | 2.07 | 0.48 | 0.33 |

| | | | | | | |
|---|---|---|---|---|---|---|
| LSD (p =0.05) | NS | NS | NS | 6.2 | 1.5 | 1.0 |
| LSD (p=0.05) (T×N Interaction) | NS | NS | 22.5 | 264.3 | NS | NS |

**Table 2:** yield attributes of pigeon pea affected by tillage and nutrient management practices

| **Treatments** | **50% flowering** | **Days to maturity** | **Length of pod (cm)** | **Number of pods per plant** | **Number of grains per pod** | **Seed index (g)** |
|---|---|---|---|---|---|---|
| **Tillage practices** | | | | | | |
| Zero Tillage | 193 | 281 | 5.6 | 175.2 | 4.0 | 12.0 |
| Permanent Bed | 193 | 281 | 5.9 | 180.5 | 4.1 | 12.2 |
| Fresh Bed | 192 | 280 | 5.2 | 166.7 | 3.5 | 11.2 |
| Conventional tillage | 192 | 279 | 4.5 | 163.0 | 3.4 | 10.6 |
| S.Em± | 0.66 | 0.52 | 0.12 | 3.32 | 0.11 | 0.28 |
| LSD (p =0.05) | NS | NS | 0.4 | 11.5 | 0.4 | 1 |
| Nutrient management | | | | | | |
| 100% RDF | 192 | 280 | 5.5 | 172.6 | 3.8 | 11.6 |
| 120% RDF | 193 | 281 | 5.6 | 176.6 | 3.9 | 12.0 |
| 80%RDF | 191 | 280 | 5.1 | 164.9 | 3.5 | 10.9 |
| S.Em± | 0.47 | 0.59 | 0.11 | 2.49 | 0.11 | 0.20 |
| LSD (p =0.05) | NS | NS | 0.3 | 7.48 | 0.35 | 0.6 |
| LSD (p=0.05) (T×N Interaction) | NS | NS | NS | NS | NS | NS |

**Table 3:** yield of pigeon pea crop affected by tillage and nutrient management practices

| **Treatments** | **Grain yield (q/ha)** | **Straw yield (q/ha)** | **Biological yield(q/ha)** | **Harvest index (%)** |
|---|---|---|---|---|
| **Tillage practices** | | | | |
| Zero Tillage | 19.5 | 56.7 | 75.2 | 26.1 |
| Permanent Bed | 21.8 | 57.1 | 79.3 | 27.5 |
| Fresh Bed | 18.2 | 56.6 | 73.9 | 24.8 |
| Conventional tillage | 18.0 | 54.3 | 70.1 | 25.7 |
| S.Em± | 0.58 | 1.63 | 0.88 | 0.80 |
| LSD (p =0.05) | 2.0 | NS | 3.1 | NS |
| Nutrient management | | | | |
| 100% RDF | 19.2 | 55.5 | 74.2 | 26.1 |
| 120% RDF | 21.1 | 58.5 | 79.5 | 26.7 |
| 80% RDF | 17.8 | 54.5 | 70.2 | 25.3 |
| S.Em± | 0.45 | 1.83 | 1.59 | 0.75 |
| LSD (p =0.05) | 1.36 | NS | 4.96 | NS |
| LSD (p=0.05) (T×N Interaction) | NS | NS | NS | NS |

## Conclusion
Finally, it was concluded that the effect of conservation tillage significantly affected the growth character, yield attributes and yields of pigeon pea crop compared to fresh bed and conventional tillage practices. Permanent bed and zero tillage practices performed better in yield maximization of pigeon pea in maize – pigeon pea intercropping system. As well as 120% RDF practices gave the maximum growth and yield attributes character and yields of pigeon pea crop compared to 80% RDF treatments.

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