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Effect of different sowing methods and seed treatment on growth and yield of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted at farmer's field in Bhagalpur district of Bihar state during the period from Rabi 2017 to 2018, to observe the effect of sowing methods with Seed Treatment on Growth and Yield of chickpea. The study aimed at finding out growth and yield attributes of two varieties of chickpea (PG-186 and Local traditional), at various locations. The experiment was laid out in simple randomized block design (RBD). 25 numbers of farmers in each of two villages (Birnoudh and Barhari under Bhagalpur district) were selected randomly, for testing the performance of improved variety with seed treatment and mechanized sowing against local check without seed treatment and manual broadcasting. The results of two varieties revealed significant variations in number of grains per plant, number of seeds per pod, the weight of 100 seeds, grain yield, straw yield, biological yield and harvest index due to different sowing methods. Mechanized sowing with seed treatment and conventional broadcast method of sowing without seed treatment affected the chickpea yield and the quality of grain. In case of varieties, significant variation was observed in all parameters, here, PG-186 showed better performance in comparison to local variety with broadcast seeding. PG-186 sown during Mid November resulted in better growth and yield parameters in comparison to traditional local variety.

Keywords: Chickpea, sowing method, yield and quality and rewari machine

Introduction

Chickpea is commonly known as gram which is one of the important pulse crops of the India. About 65% of global area with 68% of global production of chickpea is contributed by India (Umrathiya *et al*., 2015) [13]. However, chickpea production in India is slow in post green revolution years due to strong competition from wheat, rice and mustard, as expansion in irrigation and rapid technological change has favoured the latter crops at the cost of chickpea. The recent liberalization has expanded the demand for chickpea from international markets in addition to the growing domestic demand. It is observed that the productivity of chickpea is found to be low in comparison to their potential yield existing in the area. It showed improvement in chickpea production is needed through conservation, diversification of agriculture and to enhance adoption level of improved chickpea varieties, production technology. So, to increase the productivity, particularly under rainfed chickpea growing regions is one of the major challenges and concern which need to be addressed on priority basis. Variety of seed is one of the important factors for increasing productivity among the other yield attributing input available in chickpea cultivation. The genetic potential of grain yield of chickpea is still under estimated as a result of strong and dominating effects of economy. The fact is that the ultimate aim of chickpea growers is to get higher remunerative income through use of superior varieties existing once in yielding ability, disease and insect resistance and other characteristics. Chickpea plays an important role in the agro-economy and human health of India. Also, it is an essential crop for both human consumption and animal feed due to the presence of 17-31% protein in seeds and biological activity of its protein ranging between 52-78%. It supplies about four times as much as protein, eight times as riboflavin and equal caloric value compared to rice. Moreover, it is known as the meat of poor man (Alam, 2002 and, Bhattacharya *et al*., 1999) [2, 3]. The yield of chickpea in India is lower than the yield of other chickpea growing countries in the world. This is mainly due to the use of low yielding varieties as well as poor management practices. Chickpea primarily being a rabi season crop is losing its cultivable area every year due to an increase of cultivation of wheat, vegetables etc. So, we have limited scope to increase the production of chickpea in India. In this situation, we have only one way to increase chickpea production by means of using high yielding varieties, sowing method and using improved technologies. A number of agronomic practices have been found to influence the yield of chickpea (Fallah, 2008 and Iliadis, 2001) [5, 8].

Bihar, one of the most populous state of India and has predominantly an agrarian economy and considered as "Future Food Bowl" of India where major population reside in the rural areas and dependent on agriculture. Apart from above, around 90% farmers are small and marginal farmers. Hence, the goal of the agricultural production system should be to maximize income of land owning and landless rural populace to improve their livelihoods. The agriculture in Bihar is more vulnerable to the effect of different vagaries owing to complex, diverse and risk prone agro-climatic regions, production systems and farm typologies. Despite the availability of fertile soil, adequate rainfall and sufficient ground water, agricultural productivity in Bihar is very low, primarily due to complex, diverse and risk prone agro-ecologies, lack of adoption of improved management practices, value addition and exclusion of small and marginal farmers from the agricultural value chain. The State of Bihar with a geographical area of 94.2 thousand square km is divided by river Ganges into two parts, the north Bihar with an area of 53.3 thousand square km, and the south Bihar having an area of 40.9 thousand square km. Based on soil characterization, rainfall, temperature and terrain, three main agro-climatic zones in Bihar have been identified. These are: Zone-I (North West Alluvial Plain), Zone-II (North East Alluvial Plain), and Zone-III (South Bihar Alluvial Plain), each with its own potential and prospects. Agriculture is the single largest private sector occupation in Bihar and can be considered the riskiest business. The percentage of population employed in agricultural production system in Bihar is estimated to be around 80% which is much higher than the national average. High concentration of population, largely dependent on agriculture coupled with low yields of the major cereal crops, flood and draught are the major bottlenecks in the state agriculture.

Rice-Wheat cropping system is the predominant cropping system of Bihar, with chickpea also growing in certain areas. Due to the practice of long duration of rice cultivation, chickpea sowing gets delayed owing to late vacated fields in turn reduced chickpea yield. Farmers are also not practising high yielding improved varieties and good management practices. It results in reduced yield and quality. In such situations, Farmer FIRST is an opportunity for the researchers, extension professionals and farmers to work together and find appropriate ways through assessing different solutions. In order to use this opportunity to help the farmers of Bihar state in enhancing their farm production and productivity in a sustainable manner a project titled "Cross Sectional Livelihood Improvement and Income Enhancement through Agro-Enterprise Diversification" was envisaged. The Farmer FIRST Programme (FFP) is an ICAR initiative to move beyond the production and productivity, to privilege the smallholder agriculture and complex, diverse and risk prone realities of majority of the farmers through enhancing farmers-scientists interface. It is a farmer centric programme for research problem identification, prioritization and conduct of experiments and its management in farmers' conditions. The focus is on farmer's Farm, Innovations, Resources, Science and Technology (FIRST). Farmers tend to face problems related to production and natural resource management but they might not have found out solutions to overcome them.

Materials and Methods

To mitigate above challenges, the project was initiated in two villages namely Birnaudh and Barhari under Goradih block of Bhagalpur district of Bihar for maximising the profitability of the farmers through introduction of improved high yielding verity of chickpea with mechanized sowing and pre sowing seed treatment, for yield enhancement. It allows timelier sowing, which raises yield and lowers seed rate. It helps farmers to seed a crop directly into the cultivated field just after harvest of the previous crop with the minimum disturbance of the soil. A total of 50 farmers were selected (25 farmers in each village of Barahari and Birnaudh under Bhagalpur district of Bihar) for conducting this study. Farmers were used to sow local traditional variety of chickpea through broadcasting without seed treatment, and during this study the same procedure were followed by the farmers. While the experiments were conducted with mechanized sowing (Rewari seed drill machine) with seed treatment in the field of same farmers, as per availability of the land. The average of all the experimental and farmer's field data were recorded for both the years of experiment.

Experimental site

Study area (Birnoudha and Barhari village) is situated 15 km away in South of the University Head Quarter at Sabour. Birnoudha is a village in Goradih block of Bhagalpur district situated at 25.095N-86.760E. In Birnoudha, 750 acre of land area is under agriculture, with half of its agriculturally operated area being cultivated without any source of irrigation. The village Barhari is located at 25.095N and 86.760E, having 1100 acres of cultivable area. In majority (around 52%) of the area wheat is the major Rabi crop covering an area of around 400 acres, followed by maize cultivated over approximately 250 acres of land. These villages were selected because of urgent need for developmental intervention due to high proportion of resource poor and socio-economically backward classes. Purpose of selection of these villages were to enhance the innovative experimental capabilities and income of the resource poor farmers, farm women and youth who are in most urgent need of external technological and management intervention for kick-starting the development. Similarly, in Birnoudha and Barahari, agriculture is the major source of livelihood. Around three fourth of the population have operational land holdings of which more than 80% of the land holdings are small and marginal. Agriculture accounts for around 1100 acres of geographical area of the village.

Variety used
PG-186 developed at G.B. Pant University of Agriculture and Technology, Pantnagar was used in the experimental plots, sown through Rewari seed drill machine, with pre seed treatment. While farmers were using local traditional variety, without any seed treatment and through broadcasting. It matures in 125 days. Yield potential is 22-25 quintals per hectare.

Seeding and fertilizer management
Sowing was done during third week of November in each year of experiments. The crop has been sown through Rewari seed drill machine with seed treatment by fungicides (Bavistin / Mancozeb @ 2-3 g/kg seed) before sowing at row spacing of 22 centimeters. While farmers had sown their crop through broadcasting without seed treatment. Due to this, farmers were using high amount of seed (100-120 kg/ha) in their field in comparison to 70-80 kg/ha of seed material used by mechanized sowing in the experimental area. Chick pea being a leguminous crop fulfills the major part of its nitrogen requirement (about 75%) through the process of symbolic nitrogen fixation which works effectively from three to four weeks after sowing. Farmers were not using any fertilizer in chickpea cultivation, before and during the experiments. Due to this, we provided 20-25 kg per hectare of nitrogen as starter dose, along with 40-45 kg/ha of phosphorus through diammonium phosphate (DAP.).

Fig 1: Performance of chickpea at farmers field

Weed control
Chick pea being a stature crop suffers severely by infestation of weeds. One hand weeding or inter culture operation with hand hoe or wheel hoe after 25-30 days of sowing was conducted to take care of weeds. In some areas, where hoeing operation was not successful, herbicide like Metribuzin at the rate of 1.0-1.5 kg active ingredient in 800-1000 liters of water per hectare using Knapsack sprayer for control of weeds, were used at pre-emergence.

Observations recorded
The per-harvest observations except flower initiation and date of maturity were recorded at harvest in chickpea. The height (cm) of three plants (randomly selected and tagged) was recorded from the ground to the top of the main shoot periodically harvest in chickpea. At harvest, the plants used for periodical growth parameters (height and branches were utilized for recording the dry matter production. At harvest, tagged three plants of chickpea from each plot were utilized for yield attributes. The plants from the net plot were harvested to record grain and straw yields. The mature and fully ripened pods were picked from all 3 tagged plants of chickpea from each location and their number was counted and then mean was counted and then mean was worked out. All the pods taken from 3 tagged plants were threshed carefully by hand and the grains and straw were separated. The counting of grains was done manually and the average was calculated. 1000 grains were counted from the composite samples drawn and the weight was recorded for each plot. Grain yield from each plot was obtained after threshing the produce. The grains were then sun dried to record grain yield/plot, which was converted into grain yield in q ha^{-1}. The straw obtained from obtained from each plot was sun dried and weighed. The values were converted into straw yield in q/ha. The harvest index was obtained by dividing the economic yield (grain yield) by total biological yield (grain + straw) and multiplying the fraction thus obtained with 100 (Singh and Stoskopf, 1971).

$$\text{Harvest Index (HI)} = \frac{\text{Grain yield}}{\text{Biological yield } (i.e., \text{Total dry matter.production})} \times 100$$

Economics of treatments
The expenditure incurred on individual plot was worked out from the detail assessment of the fixed and variable costs involved such as land preparation, seed, plant protection, chemicals and labour engaged in different operations. Gross income for all treatment was calculated separately taking into consideration of grain and straw yield. Thereafter, net returns were calculated after subtracting expenditure incurred on the individual treatment from the gross expenditure of the same treatment. The benefit: cost was calculated as follows:

$$B:C = \frac{\text{Gross Return } \left(\frac{Rs.}{ha}\right)}{\text{Cost of Cultivation } \left(\frac{Rs.}{ha}\right)}$$

Result and Discussion
In case of improved variety (PG-186) with seed treatment and line sowing through Rewari Seeder, the average plant height in Rabi 2017-18 has been found as 35.15 cm, while in case of established farmers practice the average value for same season was 33.20 cm. Same trend was found during second year of study during 2018-19, and the values were found as 35.53 and 32.40 cm, respectively. Number of pods in chickpea was significantly influenced by sowing method. Chickpea sown through Rewari seed drill machine along with seed treatment produced significantly higher number of pods per plant than broadcast sowing, without seed treatment. Maximum number of pods was recorded in PG-186 and least number of pods per plant was obtained by the local traditional variety of chickpea. Maximum number of pods per plant was produced with mechanized sowing with seed treatment which was significantly higher than broadcast sowing without seed treatment. The result has been sown in tabular form in Table 1. A close perusal of the data in Table 1 on number of grains per pod reveal that sowing method with or without seed treatment influenced the number of grains per pod significantly. Mechanized sowing with seed treatment produced more number of grains per pod which were significantly higher than broadcast sowing without seed treatment.

Table 1: Average recorded plant height (cm), Number of branches per plant, Number of pods per plant and Number of grains per pod at harvest

Year	Plant height (cm)		Number of branch plant^{-1}		Number of pods plant^{-1}		Number of grain pod^{-1}	
	I.P.	F.T.V.	I.P.	F.T.V.	I.P.	F.T.V.	I.P.	F.T.V.
2017-18	35.15	33.20	6.92	6.13	28.55	24.92	1.58	1.29
2018-19	35.53	32.40	6.87	5.80	30.73	29.60	1.80	1.53

I.P.: Improved Variety (PG-186), F.T.V.: Farmers traditional variety

Average of 100 grain weight of chickpea recorded under two conditions i.e.

i) Mechanized sowing with seed treatment
ii) Broadcast without seed treatments were recorded. Perusal of data revealed that the 100-grain weight of chickpea mechanized sowing with seed treatment was higher in comparison to that sown by broadcasting method and without seed treatment.

In case of improved variety (PG-186) with seed treatment and line sowing through Rewari Seeder, the average 100 grain weight in Rabi 2017-18 has been found as 18.42 gm, while in case of established farmers practice the average value for same season was 14.25 gm. Same trend was found during second year of study during 2018-19, and the values were found as 17.93 and 13.07 gm, respectively. Similar findings were reported by Fazlulkabir *et al.*, 2009; Hassanuzzaman *et al.*, 2007 and Machado *et al.*, 2006. Data were collected from 50 farmers in both the villages, and biological yield of chickpea were recorded under two conditions i.e.

i) Mechanized sowing with seed treatment
ii) Broadcast without seed treatment were recorded. Perusal of data revealed that the biological yield of chickpea with mechanized sowing with seed treatment was higher in comparison to that sown by broadcasting method and without seed treatment.

Data collected from 50 farmers in both the villages, indicated higher grain yield in case of mechanized sowing with seed treatment, in comparison to broadcast method without seed treatment. Grain yield of chickpea with mechanized sowing with seed treatment has been found significantly superior over broadcast method of sowing without seed treatment. The average of grain yield of chickpea with mechanized sowing with seed treatment has been found as 18.66 and 17.13 q ha^{-1} for 2017-18 and 2018-19 years respectively. In case of broadcast sowing without seed treatment, grain yield recorded as 14.94 and 13.65 q ha^{-1} for 2017-18 and 2018-19 respectively. Similar trend as of grain yield was recorded, in straw yield in both years of experiments. The average of straw yield of chickpea with mechanized sowing with seed treatment, and broadcast traditional method was recorded as 32.38 and 27.16 q ha^{-1} for 2017-18, and 30.46 and 26.38 q ha^{-1} respectively for 2018-19. The details are mentioned in tabular form in Table 2. Highest harvest index was recorded in the case of broadcast traditional method of sowing in comparison to mechanized sowing with seed treatment. The value for both the cases in year 2017-18 was recorded as 36.56 and 35.49 respectively. Same trend was found in the second year of study and recorded as 35.99 and 34.09.

Table 2: Average recorded 100 seeds weight (gm), grain yield (qha^{-1}) straw yield (q ha^{-1}) and Harvest Index (HI)

Year	100 seed weight (gm)		grain yield (q. ha^{-1})		straw yield (q. ha^{-1})		Harvest Index (HI)	
	I.P.	F.T.V.	I.P.	F.T.V.	I.P.	F.T.V.	I.P.	F.T.V.
2017-18	18.42	14.25	18.66	14.94	32.38	27.16	36.56	35.49
2018-19	17.93	13.07	17.13	13.65	30.46	26.38	35.99	34.09

I.P.: Improved Variety (PG-186), F.T.V.: Farmers traditional variety

Economics

The data indicate that cost of cultivation was higher in case of broadcast traditional method of sowing mainly due to higher seed rate. Mechanized sowing with seed treatment recorded significantly higher gross returns as compared to broadcast traditional method. Cultivars PG-186 recorded significantly higher gross returns compared to local traditional variety. Significant variations in net returns were also observed due to sowing method as mentioned above. Higher returns were recorded in case of mechanized sowing with seed treatment in comparison to broadcast traditional sowing. The average of recorded data for the year 2017-18 and 2018-19 for these two cases were recorded as 50,140/-and 34,541/-Rs. ha^{-1} as mentioned in tabular form in Table 3. Significantly higher B:C ratio was recorded in mechanized sowing with seed treatment, in comparison to broadcast traditional method of sowing. Among both of two sowing methods, mechanized sowing with seed treatment recorded average B:C ratio as 3.14 for the year 2017-18 and 2018-19. While in case of broadcast traditional method, the average B:C ratio was recorded as 2.39. More or less similar findings were also reported by different scientists Akbar *et al.* (2011) [1], Chaitanya and Chandrika (2006) [4], Kumar and Kadian (2006) [9], Kumar *et al.* (2006) [10], Prasad *et al.* (2012) [12] and Yadav *et al.* (2007) [14].

Table 3: Economic indicators of mechanized sowing with seed treatment and farmers traditional method.

S.N.	Economic indicators	Farmers practice (traditional)	Mechanized sowing with seed treatment
i.	Cost of cultivation (Rs. /ha)	24, 850/-	23, 430/-
ii.	Gross income (Rs. /ha)	59,391/-	73,570/-
ii.	Net income (Rs. /ha)	34,541/-	50,140/-
iii.	B:C ratio	2.39	3.14

Conclusion

In Bihar, underground water is going deep at an alarming rate. There is a need to shift from high water requiring cropping system of rice-wheat to some other low water requiring crops such as chickpea during winter season. Chickpea, due to its high market price, can economically compete well with wheat. Farm mechanization in India was adopted as a means of increasing productivity of land and labour through timeliness of operations, precision placement and efficient utilization of inputs and reduction of losses at different stages. There is need to integrate the use of available human labour and animal power with mechanical sources of power. During the two years of study mechanized sowing with seed treatment has shown higher grain yield, gross return, net return and B:C ratio in comparison with broadcast traditional sowing by farmers. Timely sowing, moisture conservation, utilization of best agronomic practices has been the main reasons behind the result found. It was concluded from the study that crop sown through machine with proper production technology gives good yield as well as economically feasible as compared to traditional method of sowing of chickpea. Awareness among farming community needed to be created for using mechanized technology in chickpea growing areas.

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