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Productivity enhancement of chickpea (*Cicer arietinum*) through improved production technologies on farmer's field

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ABSTRACT

Sowing time and variety are two important factors which influence crop performance including chickpea. A field experiment was conducted at KVK Chhatarpur Madhya Pradesh winter-sown season of 2007-08 and 2011-12 to find out effect of sowing dates and weed management on weed growth, yield attributes, yield and nutrient uptake by weeds and chickpea (*Cicer arietinum* L.) under rainfed and irrigated conditions . Front line demonstrations were conducted on 92 farmers' field, to demonstrate production potential and economic benefit of improved technologies comprising wilt resistant varieties (JG 130, JG 11, JG 16 and JG 14), line sowing (40 × 10 cm), integrated nutrient management (20:60:40, NPK kg/ha). The seeds were treated with *Trichoderma viride* @ 4g/kg seed than inoculated with rhizobium and phosphate-solubilzing bacteria each @ 20 g/kg of seeds. Pre-emergence application of weedicide Pendimethalin @ 1 kg a.i /ha used for effective control of the weeds during *rabi* season of 2007-08 to 2011-12 in rainfed and irrigated condition .The improved technology recorded a mean yield of 16.00 q/ha which was 30.60% higher then that obtained with farmers' practice yield of 9.68 q/ha. The improved technologies resulted higher mean net income of ₹ 29 302/ha with a benefit cost ratio of 4.13 as compared to local practice (20 490/ha, 3.51). Irrespective of different sowing date of JG-11 chickpea variety, produced highest seed , no. of capsules/plan, no. of seeds/capsule and 100 seed weight(g) (18-22 October, 2008-09) as compared to other dates of sowing.

Key words: Chickpea, Date of sowing, Frontline demonstration, Improved technologies, Net return, Productivity

In India, chickpea (*Cicer arietinum* L.) rank first in production among all the pulses. It is cultivated on about 8.7 million hectares equivalent to one-third of the total pulses area and contributes close to 47% of the total output of the pulses (GoI 2012). However, chickpea yield has remained low, around 1 000 kg/ha which is much less than the obtainable yield. During 1970-71 to 1993-94 chickpea yield increased at an annual rate of 0.7% as compared to an annual growth rate of 2.5% in the yield of wheat. Further, chickpea has remained largely a rainfed crop with only 29% of its area under irrigation in (GOI 2012).

The genus *Cicer* consists of 44 species including the domesticated chickpea. Chickpea is one of the earliest cultivated grain legumes (Athar and Bokhari 2006). In India pulse crops are grown on 23 million ha area and produce nearly 14-15 million tonnes of pulse grains. Chickpea or Bengal gram is an important source of dietary protein (17-24%), carbohydrates (41-50.8%) and high percentage of other mineral nutrients and unsaturated fatty acids is one of the most important crops for human consumption (Kerem *et al.* 2007), and have unique property of maintaining and restoring soil fertility through biological nitrogen fixation as well as conserving, and improving physical properties of soil by virtue of their deep root system and leaf fall from pulse crops leave behind reasonable quantity of nitrogen in the sail and add up to 40 kg N/ ha to it. (Tomar *et al.* 2011).

Chickpea is the most important pulse crop of India and occupies 7.1 million ha area with a production of 5.75 million tonnes, accounting for 30.2 and 25.8% of total pulse area and production, respectively, (FAO 2011).

The main chickpea producing states are Uttar Pradesh, Rajasthan, Madhya Pradesh, Maharashtra and Andhra Pradesh. Chickpea is grown in all types of soil, viz. heavy clay to light loam, except saline and sodic sails. Well drained and sandy-loam to deep loam soils of medium fertility are considered ideal for its cultivation. Chickpea is a winter season (*Rabi*) crop; it is raised on the moisture conserved during the monsoon. It requires cool climate for its growth and development and high temperature for its maturity. Chickpea is commonly rotated with maize, pearl millet, rice, cotton, soybean-sorghum, sunflower or niger. In intercropping, it is grown with linseed, wheat, barley, mustard safflower, etc. In general, average productivity of chickpea continues to be lower (800-1 000 kg/ha) than expected from improved technology for the last 20 years, its due to

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cultivation on marginal lands, under poor management and without inputs except seed. The major constrains responsible for lower yield are inappropriate production technology, viz. broadcast method of sowing, wilt and root rot and pod-borer (*Helicoverpa*). Chickpea yield can be increased by 21 to 56% with adoption of improved technologies such as improved variety, recommended dose of fertilizer, weed management and plant protection.

Keeping this view, frontline demonstrations on chickpea were conducted to demonstrate the production potential and economic benefits of latest improved technologies on farmer's fields.

MATERIALS AND METHODS

Front line demonstrations were conducted on 65 farmers fields of five adopted villages, viz. Sukwa, Dauriya, Mudarka, Pannapura, and Chokhda of Chhatarpur district in Bundelkhand region of Madhya Pradesh during *rabi* season of 2007-08 to 2011-12 in partial irrigated condition, on light to medium soils with low to medium fertility status under soybean-gram production system. Each demonstration was conducted on an area of 0-4 ha and the same area adjacent to the demonstration plot was kept as farmers' practices. The package of improved technologies included wilt resistant varieties, line sowing, integrated nutrient management and timely weed removal. The varieties of chickpea JG-130 in 2007-08, JG-11 in 2008-09, JG-16 in 2009-10, JG-14 in 2010-11 and JG-16 in 2011-12 were included in demonstrations. The spacing was at 40 × 10 cm sown between 14 -18 October in 2007-08 , 18-22 October in 2008-09, 22-26 October in 2009-10, 26-30 October in 2011-11 and 31 October 3 November in 2011-12 with a seed rate of 75 kg/ha reported by Chaudhary *et al*. (2005) . Entire dose of N (20 kg/ha) and P (60 kg/ha) through diammonium phosphate, and K (40 kg/ha) through muriate of potash @20:60:40 kg/ha, respectively, was applied as basal before sowing. The seeds were treated with *Trichoderma viride* @ 4 g/kg seed than inoculated with rhizobium and phosphate-solubilzing bacteria each @ 20 g/kg of seeds. Pre-emergence application of weedicide Pendimethalin @ 1 kg a.i /ha was used for effective control of the weeds. In improved technology irrigation was applied at 45 days after sowing and at the early podding stage, in the absence of winter rains. The crop was harvested during the last week of February to 1st week of March every year as per the maturity.

RESULTS AND DISCUSSION

There were thirteen demonstrations in an area of 5.0 ha. each year from 2007-08 to 2011-12. The yield attributing characters a number of capsules/plant under improved technology were 115.20, 145.50, 118.20, 130.80 and 133.60 as against local check (farmers' practice), 59.20, 115.20, 85.60, 75.60 and 65.60 (Table 1) during the year 2007 to 2008, 2008 to 2009, 2009 to 2010, 2010 to 2011 and 2011 to 2012, respectively. There were 49.00, 21.00, 28.00, 42.00 and 51.00% increase in a number of capsules under demonstration of improved technology over and above local check (farmers' practice). The average number of capsules/plants were 128.70 under improved technology and 80.20 under local check, thus there were 38.20% more capsules per plant under improved technology demonstration as compared to local check. The average number of seeds/plant observed in improved technology was 1.90 as compared to 1.10 in local check. In the year 2007 to 2008, 2008 to 2009, 2009 to 2010, 2010 to 2011 and 2011 to 2012, the number of seeds/plants under improved technology and local check were 1.50 and 1.00, 2.50 and 1.50, 1.50 and 1.00, 2.00 and 1.00 and 2.00 and 1.00, respectively. The percentage increase in seeds/plant during these years was 33.00, 40.00, 33.00, 50.00 and 50.00, respectively, with and overall average 41.20 seeds/plant. As regards test weight (g/100 seed) the observation showed that during the years 2007 to 2008, 2008 to 2009, 2009 to 2010, 2010 to 2011 and 2011 to 2012 the test weight under improved technology and local check were 20.50 and 16.20, 23.50 and 18.6, 21.20 and 17.80, 22.50 and 16.50 and 22.60 and 16.00, respectively, with an average test weight 22.10 under improved technology and 17.0 under local check. The per cent increase in test weight during above year was found to be 20.70, 17.30, 16.00, 26.60 and 29.20 with an average of 22.00 %, respectively.

The productivity of chickpea ranged from 8.50 to 20.50 q/ha with an overall average of 16.00 q/ha in Chhatarpur district of Madhya Pradesh under recommended/improved production technologies. The productivity under improved technology varied from 8.50 to 12.00, 12.60 to 20.50, 10.00 to 13.50, 11.50 to 15.50 and 10.50 to 18.50 with a mean

Table 1 Yield attributing characters of demonstration crop

Year	Date of sowing	Yield attributing characters								
		No. of capsules/plant			No. of seeds/capsule			100 seed weight (gm)		
		Improved technology	Local check	% age increased	Improved technology	Local check	% age increased	Improved technology	Local check	% age increased
2007-08	14 -18 Oct.	115.20	59.20	49.00	1.50	1.00	33.00	20.50	16.20	20.70
2008-09	18-22 Oct.	145.50	115.20	21.00	2.50	1.50	40.00	23.50	18.60	17.30
2009-10	22-26 Oct.	118.20	85.60	28.00	1.50	1.00	33.00	21.20	17.80	16.00
2010-11	26-30 Oct.	130.80	75.60	42.00	2.00	1.00	50.00	22.50	16.50	26.60
2011-12	31 Oct.-03 Nov.	133.60	65.60	51.00	2.00	1.00	50.00	22.60	16.00	29.20
	Average	128.70	80.20	38.20	1.90	1.10	41.20	22.10	17.00	22.00

yield of 10.23, 18.88, 11.90, 13.50 and 14.50 q/ha during 2007-08, 2008-09, 2009-10, 2010-11 and 2011-12, respectively, (Table 2) as against a yield range between 6.29 and 15.00 q/ha with a mean of 9.68 q/ha under farmers practices (local check). The additional yield under improved technologies over farmers practice ranged from 2.28 to 6.00 q/ha with a mean of 4.14 q/ha. In comparison to farmers practice, there was an increase of 39, 21, 19, 33 and 41% in productivity of chickpea under improved technologies in 2007-08, 2008-09, 2009-10, 2010-11 and 2011-12. The increased grain yield with improved technologies was mainly because of line sowing, use of wilt resistant variety, integrated nutrient management and timely weed management. Singh (1992) reported that adoption of improved variety increased productivity by 35% than local variety of chickpea. Ali (2005) obtained increased (12%) yield of chickpea due to line sowing (40 × 10 cm) over broadcasting method of sowing. Dhingra (1986) reported 15% increased yield through proper plant population and row spacing on light interception and grain yield of chickpea under late sown conditions. Chopra (2001) reported pre-emergence application of weedicide, Pendimethalin @ 1 kg a.i /ha used for effective control of the weeds and improved 15% yield from farmers' practices and production potential and economics of chickpea based intercropping system under rainfed and irrigated condition.

Benefit-cost ratio

In order to ascertain the economic feasibility of the improved/ recommended technologies over and above the traditional farmers' practices, some economic indicators like cost cultivation, Net return and benefit-cost ratio were worked out of the basis of prevailing market price of various inputs like seed of improved varieties, fungicides and pesticides.

The economic viability of improved technology over traditional farmers' practices was calculated depending on prevailing price of inputs and output cost (Table 3). It was found that cost of production of chickpea under improved production technologies varied from ₹ 10 200 to 8 500/ha with an average of ₹ 94 486/ha as against ₹ 7 200 to 9 200/ ha with an average of ₹ 8 356/ha under farmers' practice (Local check). The improved production technologies registered an additional cost of production ranging from 955 to 1 300/ha with an average of ₹ 1 092.6/ha over local check. The additional cost increased in the improved technologies was mainly due to more cost involved in balanced fertilizer, improved seed and weed management practices. Cultivation of chickpea under improved technologies gave higher net return which ranged from ₹ 18 926 to 37 005/ha, with a mean of ₹ 29 302.20/ha as compared to under farmers' practices which recorded ₹ 11 637 to 29 400/ha with a mean of ₹ 20 490.20 There was an additional net return of ₹ 7 289 in 2007-08, ₹ 7 605 in 2008-09, ₹ 5 016 in 2009-10, ₹ 10 350 in 2010-11 and ₹ 13 800 in 2011-12 under demonstration plots. The improved technology also gave higher benefit cost ratio of 2.86, 5.23, 4.08, 4.23 and 4.27 compared to 2.28, 4.77,

Table 2 Seed yield of gram as affected by improved and local practices in farmers fields

Year	Area (ha)	Demonstration (No.)	Yield			Local check	Additional yield (q/ha) over local check	% age increased in yield over local check
			Improved technology					
			Maximum	Minimum	Average			
2007-08	5.0	13	12.00	8.50	10.23	6.29	3.94	39.00
2008-09	5.0	13	20.50	12.60	18.88	15.0	3.88	21.00
2009-10	5.0	13	13.50	10.00	11.90	9.62	2.28	19.00
2010-11	5.0	13	15.50	11.50	13.50	9.00	4.58	33.00
2011-12	16.0	40	18.50	10.50	14.50	8.50	6.00	41.00
Average	7.20	18.40	16.00	10.62	13.80	9.68	4.14	30.60

Table 3 Cost of cultivation (₹/ha), net return (₹/ha) and benefit: cost ratio of gram as affected by improved and local practices

Year	Total cast of cultivation		Net return (₹/ha)		B:C ratio		Additional cost of cultivation (₹/ha)	Additional net return (₹/ha)
	Improved technology	Local check	Improved technology	Local check	Improved technology	Local check		
2007-08	10188	9080	18926	11637	2.86	2.28	1108	7289
2008-09	8755	7800	37005	29400	5.23	4.77	955	7605
2009-10	8500	7200	26180	21164	4.08	3.94	1300	5016
2010-11	9600	8500	31050	20700	4.23	3.44	1100	10350
2011-12	10200	9200	33350	19550	4.27	3.13	1000	13800
Average	94486.60	8356	29302.20	20490.20	4.13	3.51	1092.60	8812.00

Sale rate of gram: 2007-08 ₹ 1 850/q, 2008-09 ₹ 1 960/q, 2009-10 ₹ 2 200/q, 2010-11 ₹ 2 300/q 2011-12 ₹ 2 550/q.

3.94, 3.44 and 3.13 under local check in the corresponding season.

Irrespective of different sowing dates of chickpea, 18-22 October, 2008-09 produced highest seed, no. of capsules/plats, no. of seeds/capsule and 100 seed weight (g) as compared to other dates of sowing. Chickpea yield was significantly influenced by sowing dates and variety reported by Singh *et al.* (2014). The lowest seed yield and no. of capsules/plant , no. of seeds/capsule and 100 seed weight (g) was recorded when chickpea was sown on 14-18 October. This result closely resembles to that obtained by (Dhingra *et al*.1999) who also opined that delaying in sowing decreased seed yields of chickpea. The results indicated that sowing of chickpea within 18 to 22 October is the optimum sowing date for chickpea to have optimum seed yield.

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