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PRODUCTIVITY ENHANCEMENT OF SESAME (*SESAMUM INDICUM* L.) THROUGH IMPROVED PRODUCTION TECHNOLOGIES

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ABSTRACT
The frontline demonstrations were conducted on 65 farmer's fields of five adopted villages of Chhatarpur district in Bundelkhand region of Madhya Pradesh during kharif seasons of 2008 to 2012 in rainfed condition on light to medium soil with low to medium fertility status under sesame-gram cropping system to study the productivity enhancement of sesame through improved production technologies. The results revealed that the maximum average number of capsules per plant and number of seeds per capsule (103.62 and 71.10) were obtained under improved technology over to farmer's practices (77.59 and 66.57) thus, there were 25.11 per cent more capsules per plant and 6.38 per cent seeds per capsule under improved technology as compared to local check. The maximum average test weight of sesame seeds (3.21 g) was recorded under improved technology over local check (2.70 g). The seed yields of sesame under improved technology ranged between 3.85 to 6.84 q ha^{-1} with average yield of 5.34 q ha^{-1} which was 34 per cent higher over the farmer's practice (3.45 q ha^{-1}). However, maximum average net returns (Rs.12914 ha^{-1}) as well as benefit cost ratio (2.49) were recorded under improved technologies as compared to farmer's practice (Rs.7740 ha^{-1} and 2.20).

INTRODUCTION

Sesame or gingelly (*Sesamum indicum* L.) commonly known as til (hindi) is an ancient oilseed crop grown in India and perhaps the oldest oilseed crop in the world. It is grown in an area of 7.54 million hectares with a production of 3.34 million tonnes in the world with a productivity of 443 kg ha^{-1}. India is the largest producer of sesame in the world. It also ranks first in the world in terms of sesame-growing area (24%) with about 1.8 million hectares with a total production of 0.76 million tonnes and productivity of 422 kg ha^{-1} (FAI, 2012). The crop is now grown in a wide range of environments, extending from semi-arid tropics and subtropics to temperate regions. Consequently, the crop has a large diversity in cultivars and cultural systems. This probably indicates a great opportunity for a prolonged and higher increase in productivity of sesame. Sesame seeds may be eaten fried, mixed with sugar or in the form of sweat meals and oil is used as a cooking oil in southern India. It is also used for anointing the body, for manufacturing perfumed oils and for medicinal purposes. Sesame cake is a rich source of protein, carbohydrates and minerals, such as calcium and phosphorus. Increase in sesame productivity is about 2% for Ethiopia and India and 2.8% for China in the period of 2000-2011 (FAO, 2012). Cropping system of oilseeds and pulses as well as adopted improved production technologies of sesame cultivation to increase their production than sole cropping of either crops or farmer's practices (Padhi and Panigrahi, 2006). The yield increase is due both to development and use of improved varieties and improved agronomy practices and crop protection. For many of the diseases and pests resistance occurs in sesame, e.g. resistance to phyllody (Singh *et al.*, 2007), resistance to powdery mildew and phyllody (Gopal *et al.*, 2005). The potential yield of sesame still is much higher than the actual yield, as still much damage occurs by pests and diseases, insufficient weed control, to high levels of mono cropping, lack of mechanisation (amongst others causing seed shattering when not enough labour is available during harvest) and unrealised genetic potential. Potential yields are probably as high as 2000 kg ha^{-1} (Mkamilo and Bedigian, 2007). The effect of plant population on seed yield and yield components of sesame have been reported by several workers. Seed yield per unit area increases with increases population density from 80,000 to 160,000 plant ha^{-1} and beyond this density in becomes counter productive (Delgado and Yermanos, 1975).

In general, average productivity of sesame continues to be lower (144-234 kg ha^{-1}) than expected from agricultural technology for the last 20 years, mainly due to its cultivation on marginal lands, under poor management and without inputs except seed. The major constraints responsible for lower yield are inappropriate production technologies viz; broadcast method of sowing, no use of fertilizers and untimely weed management (Khalque and Begum, 1991). The greatest limitations of increasing in productivity of crop are inadequate supply of nutrients and poor production practices are poor in native fertility (Singh and Khan, 2003). The continuous use of poor production technologies by farmers may not sustain soil fertility, productivity and profitability of sesame crop. In order to realise this opportunity, an analysis is needed of the major current constraints limiting sesame productivity in India. However, use of improved production technologies is required to improve the soil health as well as to achieve sustainable crop productivity.

Thus, use of improved production technologies of sesame offers a great scope for increasing productivity and profitability. The yield of sesame can be increased by 21-53% with adoption of improved technologies such as improved variety, recommended dose of fertilizer, weed management and plant protection. Keeping this in view, frontline demonstrations on sesame was undertaken to improve the productivity and profitability of sesame with latest improved production technologies on farmer's fields.

MATERIALS AND METHODS

The frontline demonstrations were conducted on 65 farmer's fields of five adopted villages viz; Sukwa, Barath, Doriya, Pannapura and Chokhada of Chhatarpur district in Bundelkhand region of Madhya Pradesh during kharif seasons of 2008 to 2012 in rainfed condition on light to medium soil with low to medium fertility status under sesame-gram cropping system. Each demonstration was conducted on an area of 0.40 ha and the same area adjacent to the demonstration plot was kept as farmer's practices. The package of improved production technologies included short duration, phillody (mycoplasma) resistant varieties of sesame, TKG-55 were sown in 2008, TKG-306 in 2009 and JTS-8 in 2010 to 2012 included in demonstrations. Seeds were treated with Thiram @ 2.5g kg^{-1} seed for prevention of seed-borne diseases and inoculated with PSB @ 20 g kg^{-1} seed for increasing the availability of phosphorus to crop roots. Seed sowing was done between July 08 to July 28 in 2008, July 08 to July 30 in 2009, July 08 to August 03 in 2010, July 05 to July 30 in 2011and July 05 to July 28 in 2012 with a seed rate of 5 kg ha^{-1} and line sowing with spacing was 45 cm between rows and 10 cm between plants in the row. Recommended dose of fertilizer (60:30:15:40 NPKS kg ha^{-1}) were supplied through urea, single super phosphate and muriate of potash. Full doses of phosphorus, potassium and ½ dose of nitrogen were applied as basal. The remaining half amount of nitrogen was top-dressed in two split doses at 30 DAS and 45 DAS. Weed control was done by used pre-emergence weedicide, Pendimethalin @ 1 kg a.i ha^{-1} and once hand weeding at 25 DAS for effective control of weed. Thinning should be done scrupulously to ensure recommended plant spacing within a row. The first thinning is done invariably 14 days after sowing and the second thinning 21 days after sowing. The crop was harvested during September 30 to October 15 after the leaves turn yellow and start dropping while the capsules are still greenish-yellow.

RESULTS AND DISCUSSON

The data on yield attributing characters of sesame for 5 years are presented in Table1 revealed that number of capsule per plant under improved production technology were 135.63, 115.21, 76.45, 95.13 and 95.64 as against local check (farmer's practice) which was being 100.26, 85.63, 45.81, 75.66 and 80.61 during the year 2008, 2009, 2010, 2011 and 2012, respectively. Percentages increased in number of capsules per plant under improved technology were 26.08, 25.67, 40.08, 20.47 and 15.72 per cent over the local check (farmer's practice). The average number of capsules per plant were 103.61 under improved technology and 77.59 under local check, thus there was 25.11 per cent more capsules per plant under improved technology as compared to local check. Increased number of seeds per capsule, number of capsules per plant, and dry matter production increased when the intra-row spacing increased from 30 to 90 cm (Olowe and Busari, 1994).The average number of seeds per capsule observed in improved production technology was 71.10 as compared to 66.57 in local check. In the year 2008, 2009, 2010, 2011 and 2012, the number of seeds per capsule under improved technology and local check were recorded 76.63 and 70.15, 72.55 and 69.53, 65.21 and 60.67, 70.30 and 63.23 and 70.83 and 68.25, respectively. The percentages increased in seeds per capsule under improved technology during these years were 8.46, 4.16, 6.96, 8.63 and 3.64, respectively with and over all average 6.38 seeds per capsule. As regards data on test weight of seed showed that during the years 2008, 2009, 2010, 2011 and 2012, test weight of sesame seeds under improved technology and local check were 3.37 and 2.87 g, 3.19 and 2.74 g, 2.98 and 2.46 g, 3.23 and 2.67 g and 3.26 and 2.78 g, respectively with an average test weight 3.21 g under improved technology and 2.70 g under local check. The per cent increased in test weight under improved technology during above years were found to be 14.84, 14.11, 17.45, 17.34 and 14.72 per cent with an average of 15.66 per cent.

The productivity of sesame in Chhatarpur district of Madhya Pradesh under improved production technology ranged between 3.85 to 6.84 q ha^{-1} with mean seed yields of 5.34 q ha^{-1} (Table 2). The productivity under improved technology varied from 5.23 to 6.84, 4.91 to 6.56, 3.85 to 5.60, 4.25 to 5.75 and 4.80 to 6.50 q ha^{-1} with a average seed yield of 6.13, 5.20, 4.72, 5.26 and 5.40 q ha^{-1} during 2008, 2009, 2010, 2011 and 2012, respectively as against a seed yields range between 2.10 and 4.40 q ha^{-1} with a average of 3.45 q ha^{-1} under farmer's practices (local check). The additional seed yield under improved technologies over the farmer's practices ranged from 1.62 to 2.62 q ha^{-1} with an average of 1.89 q ha^{-1}. In comparison to farmer's practices, there were an increase of 28.22%, 31.15%, 55.51%, 32.89% and 32.41% in productivity of sesame under improved technologies in 2008, 2009, 2010, 2011 and 2012, respectively. The increase in seed yields of sesame over farmer's practice was 61% by whole package, 23% by improved varieties, 14% by fertilizers management, 15% by method of sowing, 33% by weed management, 35% by plant protection and 92% by intercropping (Annual Report, AICRP on Sesame and Niger-2012). The increased seed yield with improved technologies was mainly because of line sowing, use of *Phytopthora* and Phyllody resistant variety, integrated nutrient management and timely weed management. Fertiliser response has been widely studied in other countries and the extent of the response depends on many factors: with high yielding varieties higher fertiliser rates are needed and also in cases of lower soil fertility (Tripathi and Rajput, 2007). Sometimes micronutrients and improvement of cation exchange capacity proved helpful by

Table 1: Yield attributing characters of sesame

Years	Rainfall during crop season (mm)	Rainy days during crop season (no.)	Yield attributing characters No. of capsules plant^{-1}			No. of seeds capsule^{-1}			Test weight (g)		
			Improved technology	Local check	% age increased	Improved technology	Local check	% age increased	Improved technology	Local check	% age increased
2008	348	32	135.63	100.26	26.08	76.63	70.15	8.46	3.37	2.87	14.84
2009	623	40	115.21	85.63	25.67	72.55	69.53	4.16	3.19	2.74	14.11
2010	779	47	76.45	45.81	40.08	65.21	60.67	6.96	2.98	2.46	17.45
2011	653	45	95.13	75.66	20.47	70.30	64.23	8.63	3.23	2.67	17.34
2012	556	42	95.64	80.61	15.72	70.83	68.25	3.64	3.26	2.78	14.72
Average	591.80	41.20	103.61	77.59	25.11	71.10	66.57	6.38	3.21	2.70	15.66

Table 2: Seed yield of sesame as affected by improved and local practices in farmer's fields

Years	Area (ha)	Demonstration (no.)	Seed yield (q ha^{-1}) Improved technology			Local Check	Additional yield (q ha^{-1}) over local check	%age increased in yield over local check
			Maximum	Minimum	Average			
2008	5.0	13	6.84	5.23	6.13	4.40	1.73	28.22
2009	5.0	13	6.56	4.91	5.20	3.58	1.62	31.15
2010	5.0	13	5.60	3.85	4.72	2.10	2.62	55.51
2011	5.0	13	5.75	4.25	5.26	3.53	1.73	32.89
2012	5.0	13	6.50	4.80	5.40	3.65	1.75	32.41
Average	5.0	13	6.25	4.61	5.34	3.45	1.89	35.38

Table 3: Economics of sesame production as affected by improved and local practices

Years	Economics of sesame production (Rs. ha^{-1}) Cost of cultivation		Net returns		B:C ratio		Additional cost of cultivation	Additional net returns
	Improved technology	Local check	Improved technology	Local check	Improved technology	Local check		
2008	6920	6348	11470	6852	2.66	2.08	572	4618
2009	7040	5460	8560	4980	2.21	1.91	1580	3580
2010	8075	5560	8919	5384	2.10	1.97	2515	3535
2011	9620	8225	14366	7872	2.00	1.96	1395	6494
2012	8500	6500	21254	13612	3.50	3.09	2000	7642
Average	8031	6419	12914	7740	2.49	2.20	1612	5174

use of humix (Abo-El-Wafa and Abd-El-Lattief, 2006). Hegde (1998) also reported that continuous use of integrated nutrient management to increase the productivity by 36% as compared to local variety of sesame. Kinman and Stark (1954) found that adoption of improved varieties to increased productivity by 32% as compared to local variety of sesame. Improved technology produced higher seed yield in 2008 to 2012 as compared to local check. The reason for this could be the inter plant competition for the moisture and nutrients which could be more severe under local check demonstration (Farmer's practice). Also, the higher weed infestation under the local check as evident from the higher weed cover and reduced the amount of nutrients and water available to the local check. This agrees with the findings of Imoloame *et al*. (2007) who reported the superiority of row planting over broad casting to control weed and that this factor resulted in considerable yield increased and also grain yield increased significantly.

The economic viability of improved technologies over traditional farmer's practices was calculated depending on prevailing prices of inputs and output costs (Table 3). It was found that cost of production of sesame under improved technologies varied from Rs. 6920 to 9620 ha^{-1} with an average of Rs. 8031 ha^{-1} over farmers practice (local check) varied from Rs. 5460 to 8225 ha^{-1} with an average of Rs. 6419 ha^{-1}. The improved production technologies registered an additional cost of production ranging from Rs. 572 to 2515 ha^{-1} with an average of Rs. 1612 ha^{-1} 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 sesame under improved technologies gave higher net return which ranged from Rs 8560 to 21254 ha^{-1} with an average of Rs.12914 ha^{-1} as compared to farmer's practices which recorded Rs. 4980 to 13612 ha^{-1} with average of Rs. 7740 ha^{-1}. Tripathi and Rajput (2007) reported that the highest net returns were found with application of 60 kg N, 30 kg P_2O_5 and 15 kg K_2O ha^{-1}. Similar results also have been reported by Khan *et al*., (2009). There were an additional net returns of Rs. 4618 ha^{-1} in 2008, Rs. 3580 ha^{-1} in 2009, Rs. 3535 ha^{-1} in 2010, Rs. 6494 ha^{-1}in 2011 and Rs. 7642 in 2012, respectively under demonstration plots. The improved technologies also gave higher benefit cost ratio, 2.66, 2.21, 2.10, 2.00 and 3.50 as compared to 2.08, 1.91, 1.97, 1.96 and 3.09 under local check in the corresponding years. The results from the current study clearly brought out the potential of improved production technologies in rainfed condition of Madhya Pradesh in India. To get maximum yield of sesame recommended package of practices should be followed by not following any one management practice yield may be reduced severely and it was also observed that delay in sowing, unbalanced does of fertilizer, untimely weed management and plant protection drastically reduced the grain yield of sesame.

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