Optimization of sesame (*Sesamum indicum* L.) production through bio/natural inputs

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Abstract

India ranks first in area (29%), production (26%) and export (40%) of sesame (*Sesamum indicum* L.) in the world. Sesame seeds are rich source of food, nutrition, edible oil, health care and bio-medicine. Sesame oil has excellent nutritional, medicinal, cosmetic and cooking qualities for which it is known as 'the queen of oils'. Due to the presence of potent antioxidants, sesame seeds are called as 'the seeds of immortality'. With the growing health consciousness, the international demand and export of sesame are continuously increasing. Consequently, sesame has recently emerged as a valuable export crop, presently earning over Rs. 1000/- crores of valuable foreign exchange from the export of 2.5 lakh tonnes of sesame seed. So much so, India's share in world's trade of hulled sesame has gone up to 60 % during 2002-03. However, pesticide residue had been the major problem in the promotion of sesame export. To enhance the production and export of sesame, the technology needs reorientation and refinement with emphasis on the quality of the produce to match with export standards and demands of international markets. The organically produced sesame will suit to the tailor-made requirements of the foreign buyers and will get premium in the international market.

The studies on the optimization of sesame production through the use of bio/natural inputs conducted at four centers of All India Coordinated Research Project, during 2002-03 and 2003-04 revealed that among 12 treatments with recommended dose of nutrients through different combinations of bio/natural inputs, the highest seed yields were recorded with the application of [FYM 3.75 t/ha + Neem cake @ 900 kg/ha + wood ash 75 kg/ha + bone meal 75 kg/ha + ELS 20 kg/ha + PSB 5 kg/ha + *Azotobactor* 5 kg/ha + *Trichoderma viride* (0.4%) seed treatment + Neem oil (2.0%) spray thrice at 15, 30 and 45 DAS/ *Azadrichtin* (0.03% at 30 DAS)]. The mean yield pooled over locations and years (782 kg/ha) recorded in T_2 was on par with the highest yield (786 kg/ha) recorded in T_1 with the application of recommended dose of chemical fertilizers @ 60 N+40 P+20 K+20 S kg /ha and pesticides. The maximum 1000-seed weight (2.63 g) and oil content (52.0 %) and oil yield (406 kg/ha) were also recorded in treatment T_2, besides other direct and indirect beneficial effects on agro-ecology, oil, soil and human health. The results confirmed the feasibility of substituting chemical fertilizer and pesticides by organic resources without sacrificing the yield levels in sesame crop. The use of organic sources will reduce dependence on chemical fertilizers and pesticides besides being ecologically sound and eco-friendly in nature. Marginally higher net monetary return and benefit-cost (B:C) ratio observed with the application of chemical inputs were due to the same rate of produce without consideration of premium for organic treatments.

Media summary

The maximum oil content and oil yield in sesame were recorded with the recommended doze of nutrients through bio/ natural inputs, though the observed seed yield was on par with maximum yields through chemical inputs.

Key words

Pesticide residue, sesame, sustainability, production, organics, export

Introduction

Sesame seeds are considered as micro-capsules for health and nutrition. India dominates world production and export of sesame. Long term viability of Indian agriculture depends on its competitiveness, with commercial outlook of high production with higher profit per unit area. The high production is required for ever-increasing domestic demand and higher export to earn foreign exchange. Agri-export is an important source of foreign exchange in India.

The modernization of agriculture resulted into the extensive use of chemical fertilizers, indiscriminate use of pesticides, development of pesticide/herbicide resistance, pesticide residue in produce, and disruption and degradation of agro-ecosystems. Excessive use of agro-chemicals increases pollution, decreases soil productivity and leads to nutrient imbalance. Integrated use of organic and inorganic fertilizers in a balanced proportion for sustainable production of sesame, was emphasized, among others, by USDA (1980), Pannase *et al* (1995), Tiwari *et al* (1995), Hegde (1998) and Deshmukh *et al* (2002a). Globally, with the increasing use in confectionery, sesame seed is now being looked upon more as a food item than as an oilseed. Presence of pesticide residue in sesame had been the major impediment in the promotion of sesame export. Export consignments of Indian sesame are sometimes rejected in the international market due to the presence of pesticide residue. Organically produced sesame is preferred and given premium in the global market. Therefore, studies were undertaken at Indian Council of Agricultural Research through All India Coordinated Research Project on Sesame and Niger to optimize the yield through bio/natural inputs and to evaluate the efficacy of bio/natural inputs on yield and oil content of sesame.

Methods

Twelve treatments with recommended dose of nutrients and plant protection measures through different combinations of organic/ natural resources were compared with a treatment of recommended dose of chemical fertilizers (RDF) @ 60 N+40 P+20 K+20 S kg /ha and pesticides, and absolute control without any fertilizers. The trials with 14 treatments (Table 1) were conducted in Randomized Block Design with 4 replications at Amreli, Mandor, Vridhachalam and Jalgaon centres of All India Coordinated Research Project on Sesame and Niger during rainy season of 2002-2003 and 2003-2004 with common agronomic practices. The bio/natural inputs as well as P, K and ? N in the treatment of chemical fertilizers were applied as basal doze and the rest of the N later in the growing season. The plot size of 5.0 x 3.6 m and spacing of 30 x 10 cm were followed using recommended varieties of the region. The data on seed yield, oil yield, net return and B:C ratio were recorded.

Results

At Mandor with variety RT46, all the combinations of bio/natural inputs proved their superiority in producing higher seed yields over the control (388 kg/ha). T_{10} with the application of 2.5t/ha FYM + 250 kg/ha gypsum + *T. viride* gave the maximum seed yield of 776 kg/ha, which was statistically on par with T_2, T_4, T_{12}, T_{15} T_{11}, T_{13}, T_9 and T_1 but significantly superior to T_7, T_8, T_5, T_{16}, T_3 and T_6. At Vridhachalam with variety VRI-1, the highest seed yield of 778 kg/ha was recorded in T_2 with the application of all bio/natural inputs (FYM (3.75 t/ha) + neem cake (900 kg/ha) + Ash (75 kg/ha) + Bone meal (75 kg/ha) + ELS 20 kg/ha + PSB @ 5 kg/ha (soil application) + *Azotobactor* @ 5 kg/ha + *Trichoderma viride* (0.4%) seed treatment + neem oil spray thrice at 15, 30 and 45 DAS, Azadrichitin (0.03%) at 30 DAS), which was significantly superior to rest of the treatments except 751 kg/ha recorded in T_1 with RDF through chemical fertilizers. However, the pooled mean of the two years at Amreli indicated that in Gujrat Til-2 variety, T_1 with recommended doze of nutrients as chemical fertilizers produced highest seed yield of 1143 kg/ha, which was followed by1075 kg/ha recorded in T_4 (2.5 t FYM/ha + Oil cake @ 250 kg/ha) and 1059 kg/ha recorded in T_2 with no statistical differences *inter se*. At Jalgaon also, with variety Tapi the maximum seed yield of 490 kg/ha was recorded under T_1. This was followed by 461 kg/ha recorded in T_2. Treatments T_1 and T_2 were on par to each other but significantly superior to rest of the treatments except T_3, T_4, T_{12} and T_{13}. Control treatment produced the lowest seed yield at all the locations in both the years with an over all mean of 402 kg/ha. Application of nutrients through organic/ natural inputs also showed less stress symptoms compared to inorganic fertilizer application at later part of crop growth, particularly in the light sandy soils at Mandor and Vridhachalam.

The pooled mean over the locations and years indicated that the maximum seed yield of 786 kg/ha was observed in T_1 (RDF + 20 kg S/ha through chemicals) and closely followed by 782 kg/ha recorded in T_2 (comprising of all the nutrient in organic form) with marginal difference (Table 1). Both T_1 and T_2 were found significantly superior to the rest of the treatments. From the results of the studies on the optimization of sesame production through the use of bio/natural inputs conducted at four locations of AICRP, it may be concluded that among the different combinations of bio/natural inputs, the highest seed yields were recorded with the application of [FYM 3.75 t/ha + Neem cake @ 900 kg/ha + wood ash 75 kg/ha + bone meal 75 kg/ha + ELS 20 kg/ha + PSB 5 kg/ha + *Azotobactor* 5 kg/ha + *Trichoderma viride* (0.4%) seed treatment + Neem oil (2.0%) spray thrice at 15, 30 and 45 DAS/ *Azadrichtin* (0.03% at 30 DAS)]. The positive response of bio/natural inputs was also observed on other characters with maximum 1000-seed weight of 2.63 g, oil percentage of 52.0% and consequently the oil yield of 406 kg/ha recorded in treatment T_2. However the maximum net monetary return of Rs. 12766 /ha and B:C ratio of 2.66 were obtained in T_1 with chemical inputs and closely followed respectively by net monetary return of Rs. 11812 /ha and B:C ratio of 2.39 recorded in treatment T_2 with bio/natural inputs. The yields recorded with the application of bio/natural inputs were on par with the highest yield recorded through the application of recommended dose of chemical fertilizers/ pesticides, besides direct and indirect beneficial effects on oil, soil and human health, confirming the feasibility of substituting chemical inputs by organic resources without sacrificing the yield levels in sesame crop. The organic farming is a production system, which avoids or largely excludes the use of agro-chemicals (Lampkin 1990). The use of organic sources will reduce the dependence on chemical fertilizers and pesticides besides their eco-friendly nature. Keller *et al* (2002) also concluded that organic farming gave higher or equal yield as compared to chemical farming after an initial period of three years. Organic farming also improved the quality of the produce in terms of bold sized grains, high protein content compared with chemical farming.

Table 1. Effect of bio/natural inputs in optimization of sesame production at four AICRP centres (Pooled mean of locations)

	Treatments	Seed Yield (kg/ha)			1000-Seed Weight (g)	Oil (%)	Oil Yield (kg/ha)	Economics	
		2002-03	2003-04	Mean				NMR*	B:C Ratio
T_1	Recommended dose of NPK through fertilizers + 20 kg S/ha	877	694	786	2.61	50.2	394	12766	2.66
T_2	FYM (3.75 t/ha) + Neem cake (900 kg/ha) + Ash (75 kg/ha) + Bone meal (75 kg/ha) + ELS 20 kg/ha + PSB @ 5 kg/ha (soil application) + *Azotobactor* @ 5 kg/ha + *Trichoderma viride* (0.4%) seed treatment + Neem oil spray thrice at 15, 30 and 45 DAS, Azadrichitin (0.03%) at 30 DAS	843	720	782	2.63	52.0	406	11812	2.39
T_3	FYM 5 t/ha	698	508	603	2.48	47.2	285	7308	1.87
T_4	FYM 2.5 t/ha + oil cake 250 kg/ha	768	558	663	2.50	47.0	312	9173	2.14

T_5	FYM 2.5 t/ha + R. Pen 20 kg/ha	676	519	598	2.51	48.2	288	7938	2.04
T_6	FYM 2.5 t/ha + R. Pen 20 kg/ha + PSB	658	515	587	2.51	49.0	288	7567	1.98
T_7	FYM 2.5 t/ha + *Azotobactor* + PSB	653	478	566	2.52	51.2	290	7006	1.91
T_8	FYM 2.5 t/ha + *Azotobactor* + PSB + KSB	672	505	589	2.52	51.0	300	7734	2.02
T_9	FYM 2.5 t/ha + Gypsum 250 kg/ha	694	580	637	2.58	49.0	312	9012	2.14
T_{10}	FYM 2.5 t/ha + PSB + *Azotobactor* + Gypsum 250 kg/ha + R. Pen 20 kg/ha	795	599	697	2.45	50.9	354	10277	2.31
T_{11}	T_{10} + seed treatment with *Trichoderma viride*	770	614	692	2.55	50.7	351	10332	2.34
T_{12}	T_{10} + seed treatment + foliar spray *Trichoderma viride*	792	584	688	2.53	49.5	340	10058	2.28
T_{13}	T_{10} + *Trichoderma viride* seed treat. + Neem oil spray (2%)	760	589	675	2.54	50.9	343	8760	2.00
T_{14}	No inputs	463	340	402	2.38	49.8	200	4782	1.95
	SEm ?	15.97	20.29	26.90	0.22	-	-	-	-
	CD (P= 0.05)	44.00	61.00	72.00	0.68	-	-	-	-

* NMR= Net monetary return; ELS= Elemental sulphur; PSB=Phosphorus solublising bacteria; R.Pen= Rock Phosphate enriched with FYM (1:3) for 15 Days; KSB= Potassium solublising bacteria.
Sale price of sesame= Rs. 26/kg

Conclusion

India has vast untapped potential for sesame export. However, presence of pesticide residue in sesame seeds is the major impediment due to which export consignments of Indian sesame are sometimes rejected in the international market. With the growing awareness about the ill effects of the chemicals applied to the crop in the form of pesticides, fungicides and fertilizers etc, the development and adoption of organic technology is most essential for sustainability of production and agro-ecosystem. The trials on biological crop husbandry were carried out at 4 centres of AICRP during 2002-03 and 2003-04. The results revealed that with two weeding with hand hoe at 15 and 30 DAS and required nutrients through bio/natural inputs, gave the yields on par with the highest yield recorded through the application of

recommended dose of chemicals (weedicides/ fertilizers/ pesticides. There were also other direct and indirect beneficial effects of the organic/natural inputs on the quality of oil, seed, soil, human health and ultimately on the sustainability of the eco-system. Marginally higher monetary net return and B:C ratio observed with the application of chemical inputs were due to the same market rate for both seeds without consideration of any premium on organically produced sesame. The results confirmed the feasibility of substituting chemicals in the form of fertilizers and pesticides by organic/ natural resources. Besides overcoming the major problem of pesticide residue, the sesame produced with bio/natural inputs will get premium in the international market. This in turn will reflect into higher prices in domestic market and ultimately higher profit to the growers. The sesame seed so produced will be a perfect health food with no adverse effects on human body.

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