The Pharma Innovation Journal 2022; 11(2): 372-374

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(2): 372-374

www.thepharmajournal.com
Received: 17-11-2021
Accepted: 27-12-2021

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Yield and economics of organic, integrated and inorganic crop practices in maize + blackgram

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Abstract
The field experiment was conducted during *kharif* seasons of 2015 to 2019 at the Organic Farming Unit, MPUAT, Udaipur, Rajasthan, to evaluate the effect of organic, integrated and inorganic crop management practices on yield and economics of maize + blackgram intercrop (2:1). The experiment comprises six nutrient management practices *viz.*, 100% Organic management, 75% Organic + innovative practices, 50% Organic + 50% inorganic, 75% Organic + 25% inorganic, 100% Inorganic nutrient sources and State recommendation. The significantly maximum maize equivalent yield of maize + blackgram was obtained with the application of 100% inorganic management which was higher by 3.28%, 3.51%, 5.36%, 9.15% and 13.67% over 50% Organic + 50% inorganic, 75% Organic + 25% inorganic, State recommendation, 75% Organic + innovative practices and 100% Organic management, respectively. Further, 75% Organic + innovative practices recorded higher maize equivalent yield of maize + blackgram over 100% organic management by 4.96%. Similarly, 100% inorganic management recorded the maximum net return (Rs.40521/ha) and BC ratio (1.43) followed by State recommendation (Rs. 32338/ha and 0.94).

Keywords: Organic farming, integrated, inorganic, crop management and maize + blackgram

Introduction
The extensive and indiscriminate use of chemical fertilizers and other agro-chemicals in intensive farming have deteriorated soil health, soil macro and microflora, quality of water, food and fodder (Sharma *et al.* 2017) [11] and have adversely affected the human and animal health due to their entry in food chain (Biswas and Sharma 2008) [2]. Due to ever increasing health issues posed by agrochemicals in intensive agriculture, the organic products have gained popularity among the consumers.
Rajasthan is a leading maize growing state in India and stands 1st in terms of maize cultivated area. Maize, in general, being a heavy feeder, requires more nutrients as compared to other crops. To meet nutritional requirements of maize, farmers apply imbalance and high amount of inorganic fertilizers which causes negative effect on the fertility of soil and environment.
Intercropping cereals with legumes have huge capacity to replenish soil mineral nitrogen through its ability to biologically fix atmospheric nitrogen (Maitra *et al.*, 2019) [8]. In an appropriate intercropping system, advantages, such as less weed infestation, may also accrue (Shah *et al.*, 2011) [10].
In view of above facts, a study was conducted to evaluate the effect of organic, integrated and inorganic crop management practices on yield and economics of maize + blackgram intercrop.

Materials and Methods
The experiment was conducted during *Kharif* 2015 to 2019 at Organic Farming Unit, Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan), India. Research study comprised six crop management practices under organic, integrated and inorganic crop management practices (Table 1) as per National Programme on Organic Production standards (APEDA, 2019-20) [1]. The treatments were laid out in a randomized block design without any replication and hence years were treated as replication for statistical calculation. The quantity of different organic manures was calculated based on the recommended dose of nitrogen for maize @ 90 kg ha^{-1} given 1/3rd nutrients through NADEP compost, 1/3rd by vermicompost and 1/3rd by neem cake (1/3rd) were applied before 10-15 days of sowing and thoroughly mixed in the soil. Blackgram was grown as intercrop in 2:2 row combination at 30 cm row spacing.
Maize equivalent yield: Maize equivalent yield (MEY) was calculated as per current market prices of both maize and other different types of maize (Panda 2014) [9].

Statistical analysis: The experimental data obtained from various treatments were statistically analyzed by using Analysis of variance method (ANOVA) procedure (Gomez and Gomez 1984) [5] for the RBD using R Studio software with least significant difference at the 5% level of significance ($P< 0.05$).

Results and Discussion

Organic, integrated and inorganic crop management practices had a significant effect on yield, gross and net return of maize + blackgram intercropping (Table 2). Among the different crop management practices, the maximum maize equivalent yield (3101 kg/ha) of maize + blackgram intercrop were recorded with 100% inorganic crop management practice. The comparison of different organic, integrated and inorganic crop management practices reveal that organic management practices recorded a lower maize equivalent yield of 284 to 424 kg/ha in comparison to inorganic crop management practices. However, the effect of 50% organic + 50% inorganic, 75% organic + 25% inorganic, state recommendation and 75% organic + innovative crop management practices were found at par with each other.

Among the different crop management practices, the maximum gross return (Rs. 70362/ha), net return (Rs. 40521/ha) and BC ratio (1.43) of maize + blackgram were recorded with 100% inorganic crop management practice. The organic management practices recorded a lower net return of Rs. 26928 to Rs. 34796/ha in comparison to inorganic crop management practices (Table 2).

Pooled data of 5 year study suggested that nutrient supply through inorganic sources resulted a higher maize equivalent yield but its effect was found at par with crop integrated nutrient management practices. This may be attributed to superior effect of continuous application of organic manures on improving soil physical (Hati *et al*. 2007) [6]., chemical conditions (Fan *et al.* 2005) [4]. resulting in better nutrient cycle in the soil profile which in turn increased system productivity (Kaur *et al*. 2008) [7].

Table 1: Details of treatments

Organic crop management	CM 1: 100% Organic management	Nutrient management: 1/3 of RDN by NADEP compost + 1/3 by vermicompost + 1/3 by Non-edible Cake + BF; All other management practices as per NPOP guidelines
	CM 2: 75% Organic + innovative practices	(1/3 of RDN by NADEP compost + 1/3 by vermicompost + 1/3 by non-edible cake + BF) + Innovative practices (BD 500 @ 75g/ha before sowing & 30 DAS + BD 501 @ 2.5g/ha @ 2-4 leaf stage + Mataka Khad 10% at 3 WAS + Panchagavya @ 3% 6 WAS.
Integrated crop management	CM 3: 50% Organic + 50% inorganic	(1/3 of RDN by NADEP compost + 1/3 by vermicompost + 1/3 by Non edible cake + BF; integrated management) + 50% inorganic (Fertilizers & chemical management)
	CM 4:75% Organic + 25% inorganic	(1/3 by NADEP compost + 1/3 by vermicompost + 1/3 by non-edible cake + Azotobacter; integrated crop management) + 25% inorganic (Fertilizers & chemical management)
Inorganic crop management	CM 5: 100% Inorganic Nutrients sources	
	CM 6: State recommendation (10t FYM/ha once in 2 years + fertilizers & pesticides as given in the crop production guide of state).	

Table 2: Effect of organic, integrated and inorganic crop management practices on maize equivalent yield and economics of maize + blackgram intercropping (Mean of five years)

	Treatments	MEY (Kg/ha)	Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	B:C ratio
Organic management practices	100% Organic	2677	64766	58707	6059	0.12
	75% Organic + Innovative Practices	2817	66014	52421	13593	0.28
Integrated management practices	75% Organic + 25% Inorganic	2992	68842	51482	17360	0.37
	50% Organic + 50% Inorganic	2999	70125	44273	25852	0.62
Inorganic management practices	100% Inorganic Management	3101	70362	29841	40521	1.43
	State Recommendation	2943	67841	35503	32338	0.94
S.Em ±		103.931	1940.537		1940.537	0.091
CD at 5%		306.595	5724.580		5724.580	0.270

Vermicompost unit

Enriched compost

NADEP compost production

Trichoderma incubated FYM

Mataka Khad

Farm waste incubation tank

Fig 1: Organic manure used in organic maize

Conclusion

Among six crop management practices used for cultivation of maize + blackgram (2:2), for five years, the maximum maize equivalent yield, net return and B: C ratio was found with the use of 100 per cent inorganic management practices which was significant over the organic management practices and was observed at par with integrated crop management practices.

Acknowledgements

We acknowledge the financial support of ICAR- All India Network Project on Organic Farming, Indian Institute of Farming System Research, Modipuram, Meerut, India for this study.

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