LR-5031
[1-6]

RESEARCH ARTICLE Legume Research- An International Journal, Volume Issue : ()

Productivity Dyanamics of Blackgram with Intercropping of Minor Millets on BBF under Organic Cultivation

Adinath N. Paslawar[1], Shital Mhashakhetri[1], P.V. Shingrup[1], P.N. Chirde[1], Nilima K. Darekar[1] 10.18805/LR-5031

ABSTRACT

Background: Intercropping is an important aspect than sole cropping to address the issues of *rainfed* agriculture as well as organic agriculture under changing climate scenarios and it also helps in the maximization of productivity and profitability by efficient utilization of natural resources like light, land and water. Moreover, intercropping improves soil fertility through atmospheric nitrogen fixation with the inclusion of legumes and helps in soil conservation through the greater ground cover. Health benefits of minor millets are important in human diet and inclusion of minor millets in intercropping system with pulses are important component of organic agriculture.

Methods: The field experiment entitled "productivity dyanamics of blackgram with intercropping of minor millets on bbf under organic cultivation'' was conducted during *Kharif* season of 2019-22 at certified organic research farm of Centre of Organic Agriculture Research and Training (COART), Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra).

Result: In case of blackgram, the crop growth parameters and yield attributes of blackgram were found to be improved with sole cropping of blackgram than intercropping system with minor millets. However, in case of minor millets, crop growth parameters and yield attributes of minor millets were found to be higher intercropping system with blackgram.

Key words: Blackgram, Intercropping, Minor millets, Organic farming, Productivity.

INTRODUCTION

Organic agriculture is a production system that sustains the health of soil, ecosystem and people. It relies on ecological processes biodiversity and cycles adapted to local conditions rather than the use of input with adverse effects. Unlike chemical farming, organic farming aims to "feeding the soil" rather than "feeding the plant". It is the means of giving back to nature what has been taken from it. Since organic farming aims at maintaining soil health the optimum yield can be obtained in a sustainable and eco-friendly manner in the long run. After the green revolution fertility of the soil has been degraded due to intensive cultivation, use of high doses of chemical fertilizers and insufficient use of organics *i.e.* farmyard manure, compost, crop residue, green manure, bio-fertilizers, *etc*. At present time we face many challenges to achieve sustainable food security and quality of food materials. Intercropping as an example of sustainable agricultural systems following objectives such as: ecological balance, more utilization of resources, increasing the quantity and quality and reduce yield damage to pests, diseases and weeds (Udhaya Nandhini and Somasundaram, 2020). Intercropping is a system that focuses on the better exploitation of sunlight, effective utilization of nutrients and water, risk reduction and higher exploration of the growth factors from the environment (Mobasser *et al*., 2014; Ajibola and Kolawole, 2019). The potential of intercropping is well known for multifaceted benefits like greater resource use, reduction of population of harmful biotic agents, higher resource conservation and soil health and agricultural sustainability. These benefits are prominently pronounced in drylands. On the other hand, small millets are important ecologically hardy crops of drylands which can provide food and nutritional security to smallholders. On the basis of available literature studied it can be said that intercropping small millets in drylands is one of the suitable options to harness ecologically sound agriculture. There is enough scope for future research which can further boost economy of smallholders with agricultural sustainability in drylands (Maitra, 2020). Pulses are an integral part of cropping systems in India as their versatility allows them to be used in organic systems in different ways as in rotations, intercropping, Ley farming and as a cover crop. India being the premier pulse growing country ranked first in area and production with 35% and 25.79% respectively of global pulse production. In India, the area and production of total pulses were 29.44 million hectares and 23.13 million tonnes respectively with an average yield of 786 kg ha^{-1} and among which Maharashtra

[1]Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola-444 104, Maharashtra, India.

Corresponding Author: Adinath Paslawar, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola-444 104, Maharashtra, India. Email: adinathpaslawar@rediffmail.com

How to cite this article: Paslawar, A.N., Mhashakhetri, S., Shingrup, P.V., Chirde, P.N. and Darekar, N.K. (2023). Productivity Dyanamics of Blackgram with Intercropping of Minor Millets on BBF under Organic Cultivation. Legume Research. doi:10.18805/LR-5031.

Submitted: 29-08-2022 **Accepted:** 10-05-2023 **Online**: 01-06-2023

state shares 4.36 million hectares and 3.77 million tonnes of area and production respectively with an average yield of 865 kg ha^{-1} in 2016-17 (Anonymous, 2018).

Blackgram (*Vigna mungo* L), is an important pulse crop containing about 26% protein and is an important part of the Indian diet. Blackgram crop is a mini fertilizer factory as it restores soil fertility by fixing atmospheric nitrogen and thus producing nitrogen equivalent of around 22 kg per hectare. It is popularly known as "urd bean" is an important short duration and self-pollinated *kharif* legume crop. It is a rich source of protein (25-28%), carbohydrates (62-65%), fiber (3.5-4.5%), ash (4.5-5.5%), amino acids like lysine, vitamins like thiamine, niacin, riboflavin and much-needed iron and phosphorous (Sohel *et al*., 2017). Blackgram is used as a green manuring crop and it possesses a deep root system that binds soil particles and thus prevents soil erosion. The globally production of black grams is around 8.5 million tonnes, from the major producing countries such as India, Myanmar. India contributes nearly 70 per cent of the world's production (thehindu business line.com). Blackgram accounts for about 10 per cent of India's total pulse production. Blackgram cultivated area in India in about 3.24 million hectares with average productivity of at 469 kg per hectare (thehindubusinessline.com). But due to continues rains in *kharif* season, the quality and quantity of blackgram production has limitation, hence intercropping of minor millets with blackgram management remunerate under organic farming.

Millets have been called "Nutrigrains" since they are rich in micronutrients like minerals and B complex vitamins. Small millets have gained their attention owing to their inherent capacity of early maturity, higher yields due to C4 plant type, capacity to yield even in poor soil under low rainfall and poor management conditions; hence they are popularly known as "climate-resilient" crop in Indian agriculture. Small millets provide much-needed food and fodder security of the nation. Among minor millets, foxtail millet and barnyard millet have a low glycine index. Consumption of these grains has demonstrated positive health benefits among the diabetics and they are known as "wonder grains". These organically grown crops needs low input under varied climatic condition and high demand of minor millets during fasting period in Indian culture. United Nations has declared 2023 as the International Year of Millets. The primary aim of this to increase the awareness of millets regarding to health and promotes the farmers to increase production of millets.

MATERIALS AND METHODS

The field experiment was conducted during *Kharif* season of 2019-20 at certified organic research farm of Centre of Organic Agriculture Research and Training (COART), Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra). The experiment location is situated in subtropical zone at latitude of 20°42′N and longitude 77° 01′E. The altitude of the place is 287 meters above mean sea level. The experimental plot soil was clayey in texture. The soil was slightly alkaline in reaction. Among nutrient status, it ranged medium in organic carbon (0.52%), low in available nitrogen (220 kg ha^{-1}), very low in available phosphorus (17.2 kg ha^{-1}) and high in available potassium (337.6 kg ha^{-1}).

The experiment was laid out in Randomized Block Design (RBD) with seven treatments *i.e.* intercropping system (T_1 - Sole Blackgram, T_2 - Foxtail millet, T_3 - Finger millet, T_4 - Barnyard millet, T_5 - Blackgram + Foxtail millet (2:1), T_6 - Blackgram + Finger millet (2:1), T_7 - Blackgram + Barnyard millet (2:1) and three repetition of treatments. The varieties adopted are Black Gold (Blackgram), Phule Nachani (Finger millet), Co-1 (Foxtail millet) and Phule Bharati-1 (Barnyard millet). The other cultural practices were kept common, as recommended. The experimental site status presented in Fig 1, 2 and 3.

The consequent observation on growth, yield and quality parameters recorded treatment wise. The growth attributes such as plant height measured manually by using meter scale, number of leaves measured manually by simple counting, leaf area (dm^2) measured digitally on machine while total dry matter production (g) per hill measured manually by weighing the dry weight of plant. The observations on yield and yield attributes were recorded after the harvest of crops. Plants from the net plot area of each crop were harvested separately according to their harvesting dates leaving border rows after collecting the five tagged observation plants. Blackgram (78 days), finger millet (105 days), barnyard millet (82 days) and foxtail millet (90 days) were harvested by manual labour by completely slashing the shoot while leaving the root biomass in the field. The threshing of blackgram, barnyard millet, finger millet and foxtail millet was carried out manually by labor and the straw was spread over the field for *in situ* decomposition. The seeds and straw of blackgram, finger millet, barnyard millet and foxtail millet were cleaned, dried and weighed. The growth and yield parameter *viz*. plant height(cm), number of leaves, leaf area plant^{-1} (dm^2), total dry matter production (g) per hill, grain yield (kg ha^{-1}), stalk yield (kg ha^{-1}) and biological yiled (kg ha^{-1}) has been interpreted on general mean basis. As the crops are different and for the statistical analysis same crop are required so we take the data on mean basis. Similarly the analysis done by Paul *et al.* (2015), Gupta *et al* (2019). However, the randomized block design has been applied to the economics, BEY and LER.

The total value of produce *i.e*., seed and straw yield was calculated treatment wise as per the prevailing MSP and GMR was calculated. The total cost of cultivation was calculated considering the inputs used in each treatment with prevailing market rates. The total cost of cultivation was negated by the GMR to obtain NMR. The benefit-cost ratio was calculated by dividing the GMR with the total cost of cultivation.

The yields of the intercrops are appropriated to the blackgram equivalent yield (kg ha^{-1}) by using the formula which was given by Lal and Ray (1976).

$$\text{BEY} = \frac{\text{Intercrop yield} \times \text{Price of intercrop}}{\text{Price of blackgram}} + \text{Blackgram yield}$$

Fig 1: General view of experimental plot.

Fig 2: T_1 - Sole blackgram.

Fig 3: Blackgram + Finger millet (2:1).

Land equivalent ratio (LER) is the most common index adopted in intercropping to measure the land productivity. It is often used as an indicator to determine the efficacy of intercropping (Brintha and Seran, 2009). The LER is a standardized index that is defined as the relative area required by sole crops to produce the same yield as intercrops (Mead and Willey, 1980). LER compares yields from growing two or more crops together with yields from growing the same crop in monocultures or pure stands. LER was calculated as:

$$LER = \frac{Yjj}{Yii} + \frac{Yji}{Yij}$$

Where,

Yii and Yjj = Denote yield of crops i and j in sole cropping.

Yij and Yji = Corresponding yield in intercropping.

An LER of 1.0 indicates that intercropping and sole cropping have yield equivalent. LER >1.0 indicates that intercropping has yield advance over sole cropping while an LER<1.0 indicates a disadvantage of intercropping. The statistical method of analysis of variance was used for analyzing the data. The data were statistically analyzed by 'Analysis of Variance' method (Panse and Sukhatme, 1967) and 'F' test of significance was used for testing the 'null hypothesis' in order to determine whether the observed treatment effects were real and discernible from chance effects. Whenever the results were found to be significant, critical difference (C.D.) was calculated for the comparison of treatment means at 5 per cent levels of significance (P = 0.05). The results have been presented in the form of summary table providing S.E. (m) in each case and C.D. at 5 per cent level. The values of C.D. have been taken into account for drawing conclusions.

RESULTS AND DISCUSSION

The pooled data of three year of experiment (2019-22) pertaining to growth attributes presented in Table 1 showed that various growth attributes of blackgram and minor millets was influenced by different intercropping system at harvest stage. In case of blackgram, maximum growth attributes such as plant height (cm), number of leaves, leaf area (dm^2) and dry matter production (g) per hill were observed highest in sole blackgram cropping system than blackgram + minor millet cropping system. In case of minor millets, at harvest stage of minor millets, sole cropping of finger millet, foxtail millet and barnyard millet attained maximum growth attributes such as plant height (cm), number of leaves, leaf area (dm^2) and dry matter production (g/plant) as compare to millets when intercropped with blackgram in 2:1 row proportion. The increased in growth attributes such as plant height (cm), number of leaves, leaf area (dm^2) and dry matter production (g/plant) of blackgram and minor millets in sole cropping, might be primarily due to increased competition between plants for sunlight and nutrients which compelled the plants to grow more vertically rather than horizontally.

The shorter plants of blackgram and minor millets were found when intercropped 2:1 row ratios. This was due to interspecies and cooperative interaction of intercrops with blackgram for non-renewable resources like water, nutrients and light. These results corroborated with the finding of Baldevram *et al*., (2005) Pradhan *et al*., (2014) and Prasad (2014).

Three years pooled data on yield of blackgram + minor millet (2:1) cropping system experiment (2019-22) pertaining to yield presented in Table 2 showed that seed, stalk and biological yield (kg ha^{-1}) of blackgram and minor millets were highest in sole cropping rather than their inter cropping i.e. blackgram + minor millet intercropping system. Whereas, blackgram + foxtail millet (2:1) intercropping system recorded maximum harvest index (%) and seed to stalk ratio than other blackgram based intercropping and sole cropping systems. The increased in yield of sole blackgram and minor millets might be due to higher plant population in sole cropping than their intercropping system *i.e.* 2:1 ratio of blackgram + minor millet intercropping system, which finally resulted in maximum yield and also due to higher competition offered by intercrops for natural resources like space, plant nutrient, moisture and incoming solar radiation. Similar result was also reported earlier by Kumar *et al*. (2006), Nigade *et al*., (2012), Girisha (2013) and Sarma *et al*., (2016). Harvest index was positively correlated with grain yield but negatively correlated with vegetative growth. Similar results were supported by Prajapat *et al*. (2015).

Economics (GMR, NMR and B:C), blackgram equivalent yield (BEY) and land equivalent ratio (LER) presented in Fig 4, 5 and 6 *i.e*. the pooled results of three year of experiment (2019-22) revealed that the blackgram equivalent yield differed significantly due to different cropping systems.

Significantly highest gross monitory return and net monitory return were recorded with intercropping of blackgram with finger millet than all other cropping systems, it was followed by sole blackgram, blackgram + foxtail millet, blackgram + barnyard millet, sole finger millet, sole barnyard millet and lowest gross return as well as net returns was recorded with sole foxtail millet. Remarkable improvement in GMR and NMR due to blackgram + finger millet could be attributed to greater productivity and market price of both the crops (Fig 4). It also might be due to both blackgram and minor millets are low input crops, which improved the net returns under organic farming. Similar views were expressed by Shashidhara *et al*., (2000) and Maitra *et al*., (2001). In case of B:C ratio, highest value of B:C ratio was observed with blackgram + finger millet (2:1) intercropping system which was about 3.11 and lowest B:C ratio was recorded with sole foxtail millet (1.09). Similar results also earlier reported by Sharmili and Manoharan (2014) and Nighade *et al*. (2012).

Among different sole and intercropping systems, (Fig 5) blackgram + finger millet (2:1 ratio) recorded significantly highest blackgram equivalent yield of 902 kg ha^{-1}, which was observed statistically at par with sole blackgram (860 kg ha^{-1}) and stood better than remaining cropping systems

Table 1: Pooled growth attributes at harvest of blackgram and minor millets as influenced by intercropping systems.

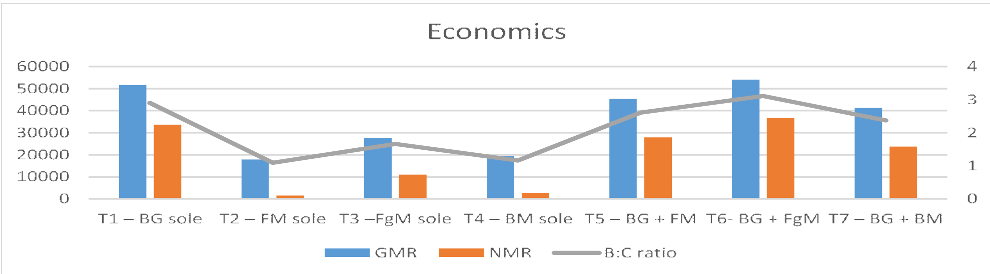
Treatments	Plant height (cm)				No. of leaves				Leaf area plant^{-1} (dm^2)				Total dry matter production (g) per hill			
Intercropping systems	Main crop	Intercrop			Main crop	Intercrop			Main crop	Intercrop			Main crop	Intercrop		
	BG	FgM	FM	BM	BG	FgM	FM	BM		FgM	FM	BM	BG	FgM	FM	BM
T1 - BG sole	43.3				17.7				4.2				16.46			
T2 - FM sole			64.0				7.5				46.4				19.00	
T3 - FgM sole		91.4				13.1				58.1				27.12		
T4 - BM sole				101.8				8.2				73.6				28.50
T5 - BG + FM	32.4		60.5		9.8		8.1		3.7		49.8		15.16		19.29	
T6 - BG + FgM	36.3	86.4			13.3	15.7			4.1	61.1			16.34	27.48		
T7 - BG + BM	37.6			95.2	7.2			9.1	3.5			76.6	14.10			28.79
GM	37.4	88.9	62.2	98.8	12.0	14.4	7.8	8.7	3.9	59.6	48.1	75.1	15.51	27.3	19.13	28.64

Note: BG- Blackgram, FgM- Finger millet, FM- Foxtail millet, BM- Barnyard millet.

Table 2: Pooled grain yield of blackgram and millets (kg ha^{-1}), stalk yield (kg ha^{-1}), biological yield (kg ha^{-1}), harvest index (%) and seed to stalk ratio of blackgram and minor millets as influenced by intercropping systems.

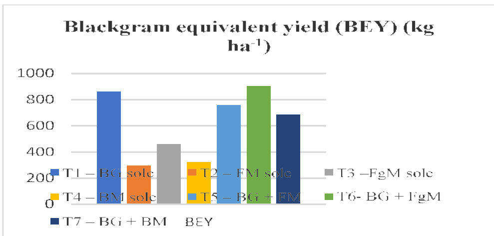
Treatments	Grain yield (kg ha^{-1})				Stalk yield (kg ha^{-1})				Biological yield (kg ha^{-1})			
Intercroppingsystems	Main crop	Intercrop			Main crop	Intercrop			Main crop	Intercrop		
	BG	FgM	FM	BM	BG	FgM	FM	BM	BG	FgM	FM	BM
T1 - BG sole	898	-	-	-	1122				2020	-	-	-
T2 - FM sole		-	750	-			1312		-	-	2062	-
T3 - FgM sole		798	-	-		1326			-	2124	-	-
T4 - BM sole		-	-	835				1520	-	-	-	2355
T5 - BG + FM	627	-	427		726		669		1353	-	1096	
T6 - BG + FgM	657	483	-	-	813	842			1470	1325	-	-
T7 - BG +BM	531	-	-	475	632			814	1163	-	-	1289
GM	678	641	589	655	823	1084	991	1167	1502	1725	1579	1822

Note: BG - Blackgram, FgM - Finger millet, FM - Foxtail millet, BM - Barnyard millet.



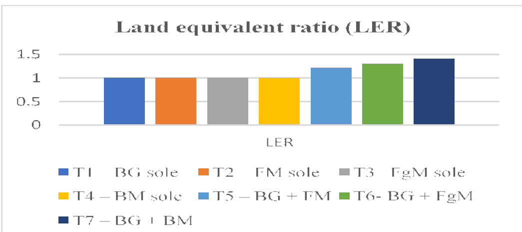
Note: BG - Blackgram, FgM - Finger millet, FM - Foxtail millet, BM - Barnyard millet.

Fig 4: Pooled economics of blackgram and minor millets as influenced by intercropping systems.



Note: BG - Blackgram, FgM - Finger millet, FM – Foxtail millet, BM - Barnyard millet.

Fig 5: Blackgram equivalent yield (BEY) of blackgram and minor millets as influenced by intercropping systems.



Note: BG - Blackgram, FgM - Finger millet, FM - Foxtail millet, BM - Barnyard millet.

Fig 6: Land equivalent ratio (LER) of blackgram and minor millets as influenced by intercropping systems.

i.e. blackgram + foxtail millet (757 kg ha^{-1}), blackgram + barnyard millet (687 kg ha^{-1}), sole finger millet (459 kg ha^{-1}), sole barnyard millet (322 kg ha^{-1}), however, lowest BEY was noticed in sole foxtail millet (297 kg ha^{-1}) system. The blackgram + finger millet (2:1 ratio) intercropping system yielded highest blackgram equivalent yield because of additional advantage of intercrop yield and higher yield of blackgram with finger millet due to better complementary relationship between both crops and also due to the higher market price of finger millet. Similar results were also reported by Jena *et al.* (2000) and Shashidhara *et al.* (2000).

Maximum value of land equivalent ratio was noticed in intercropping of blackgram + finger millet which established its superiority by recording LER of 1.31, however, it was followed by remaining intercropping systems i.e. blackgram + foxtail millet and blackgram + barnyard millet having the LER of 1.22 and 1.14, respectively (Fig 6). This might be due to higher yield of blackgram and finger millet in intercropping systems and also intercropping systems gave higher land utilization as compared to sole crops.

CONCLUSION

From the present study, it is inferred that the sole cropping of blackgram recorded maximum values of growth parameters, however, in case of minor millets; these parameters were maximum in intercropping system of minor millets with blackgram. The yield and yield parameters were highest in blackgram + finger millet (2:1) intercropping system. Also, blackgram + finger millet (2:1) intercropping found as the most efficient cropping system by recording significantly higher blackgram equivalent yield, land equivalent ratio, gross monetary returns, net monetary returns and B:C ratio. Thus, the pulses based intercropping system could be used to construct a biologically diverse agricultural system that can replenished and maintained soil fertility, while also promoting a healthy environment for better crop growth.

ACKNOWLEDGEMENT

I acknowledge to Honourable Vice-Chancellor and Directorate of Research, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra for well guidance, support and providing facilities that are necessary during conduction of experiment.

Conflict of interest: None.

REFERENCES

Ajibola, A.T. and Kolawole, G.O. (2019). Agronomic evaluation of performance of sesame varieties in maize-based intercropping system in the southern guinean savanna of Nigeria. Journal of Experimental Agriculture International. 37(3): 1-10.

Anonymous, (2018). Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministery of Agriculture and Farmers Welfare, Government of India.

Baldevram, G.R., Chaudhary, A.S, Jat, M.L. (2005). Effect of integrated weed management and intercropping system on growth and yield of pearl millet. Indian J. Agron. 50(3): 210-213.

Brintha, I. and Seran, T.H. (2009). Effect of paired row planting of raddish (*Raphanus sativus* L.) intercropped with vegetable amaranths (*Amaranths tricolor* L.) on yield components in sandy regosol. J. Agric. Sci. 4: 19-28.

Girisha, G.C. (2013). Intercropping of blackgram [*vigna mungo* (L.) Hepper.] in finger millet [*Eleusine coracana* (L.) Gaertn.] under different methods of establishment. M.Sc. thesis. University of Agricultural Sciences GKVK, Bangalore.

Gupta, K.C., Kumar, V., Praharaj, C.S. and Yadav, M.R. (2019). Productivity and profitability of chickpea + linseed intercropping system as influenced by spatial arrangement of crops in Semi-arid Eastern Plain Zone of Rajasthan. Journal of Crop and Weed. 15(2): 110-114.

Jena, B.K., Patro, H. and Panda, S.C. (2000). Intercropping in finger millet environment and ecological. International Journal of Current Microbiology and Applied Sciences. 18(2): 463-464.

Lal, R.B. and Ray, S. (1976). Economics of crop production of different intensities. Indian J. Agric. Sci. 46: 93-96.

Maitra S, Gosh D.C., Sunda G. and Jana P.K. (2001). Performance of intercropping legumes in finger millet (*Eleusine coracona*) at varying fertility levels. Indian J. Agronomy. 46(1): 38-44.

Maitra, S. (2020). Intercropping of small millets for agricultural sustainability in dry lands: A review. Crop Res. 55 (3 and 4): 162-171.

Mead, R. and Willey, R.W. (1980). The concept of a land equivalent ratio and advantages in yields from intercropping. Expl. Agric. 16: 217-228.

Mobasser, H.R., Vazirimehr, M.R. and Rigi, K. (2014). Effect of intercropping on resources use, weed management and forage quality. International Journal of Plant, Animal and Environental Sciences. 4: 706-13.

Nigade, R.D., Karad, S.R. and More, S.M. (2012). Agronomic manipulations for enhancing productivity of finger millet based on intercropping system. Advance Research Journal of Crop Improvement. 3(1): 8-10.

Kumar, R., Hooda, R.S., Singh, H. and Nanwal, R.K. (2006). Performance of intercropping and strip cropping systems of pearl millet-legume association. Indian J. Agric. Sci. 76 :39-321.

Panse, V.G. and Sukhatme, P.V. (1967). Statistical Methods for Agricultural Workers. 2: 197. Indian Council of Agricultural Research, New Delhi.

Paul, S.K., Majumdar, S., Mujahidi, T., Roy, S.K. and Kundu, S. (2015). Intercropping coriander with chickpea for pod borer insect suppression. World Journal of Agricultural Sciences. 11(5): 307-310.

Pradhan, A., Rajput, A.S. and Thakur, A. (2014). Yield and economic of finger millet [*Eleusine coracana* (L.) Gaertn] intercropping system. Int. J. Curr. Microbiol. App. Sci. 3(1): 626-629.

Prajapat, A.L., Saharan, B., Buarnia, A.L., Mohd. Arif and Jain K.K. (2015). Evaluation of growth and yield attributes of pearl millet based intercropping system in hyper arid partially irrigated western Rajasthan. Trends in Biosciences. 8(16): 4419-4423.

Prasad, H.D. (2014). Planting Pattern and Weed Management Studies in Black Gram + Finger Millet Intercropping System. M.Sc. Thesis. Birsa Agricultural University, Kanke, Ranchi, Jharkhand.

Sarma, D., Saikia, P., Bhattacharjee, M., Hazarika, M., Rajbonshi, R., Goswami, R.K., Sarma, P.K., Sarma, M.K., Neog, P. (2016). Effect of intercropping greengram and blackgram in sesame for augmenting the productivity and rain water use efficiency under rainfed upland condition. Indian J. Dryland Agric. Res. And Dev. 31(1): 51-55.

Sharmili, K. and Manoharan, S. (2014). Studies on intercropping in rainfed little millet (*Panicum sumatrense*). Int. J. Curr. Microbiol. App. Sci. 7(2): 323-32.

Shashidhara, G.B., Basavarala, R. and Nadagouda, V.B. (2000). Studies on pigeonpea intercropping system in small millet under shallow red soil. Karnataka journal of Agricultural Science. 13(1): 7-10.

Sohel, M.H., Miah, M.R., Mohiuddin, S.J., Islam, A.K., Rahman, M.S. and Haque, M.A. (2017). Correlation and path coefficient analysis of black gram [*Vigna mungo* (L.) Hepper]. Journal of Bioscience and Agriculture Research. 7(1): 621-629.

Udhaya, N.D. and Somasundaram, E. (2020). Intercropping-A substantial component in sustainable organic agriculture. Indian Journal of Pure and Applied Biosciences. 8(2): 133-143.