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Effect of Intercropping with Pulses on Growth and Yield of Finger millet. (*Eleusine coracana* L.)

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Abstract
A field experiment was conducted during kharif season at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.4), low in organic carbon (0.51%), available N (78.9 kg/ha), available P (32.88 kg/ha) and available K (385.10 kg/ha). The treatments consisted of 3 pulse crops (Cowpea, Black gram and green gram) and 3 row ratios (2:1, 4:1 and 6:1) along with recommended doses of nitrogen, phosphorus and potassium (60-30-30 kg N-P- K/ha). The experiment was laid out in a Randomized Block Design with 13 treatments and replicated thrice. In sole planting (treatment 10) plant height of finger millet was significantly high but among the intercropping treatments (treatment 4) finger millet along with black gram in 2:1 ratio recorded highest plant height (92.73 cm) and maximum plant dry weight (19.49 g). Whereas intercropping black gram with finger millet in 6:1 ratio (treatment 6) recorded a greater number of tillers (8.5). Fingers/plant (5.86), Grain yield (1532.88 kg/ha), Straw yield (3216.50 kg/ha) and land equivalent ratio (1.68) was recorded high when green gram was intercropped with finger millet in 6:1 ratio (treatment 9).

Keywords: Black gram, cowpea, finger millet, green gram**,** growth parameters, intercropping, yield parameters

Introduction
Millets have been designated as super cereals by virtue of their better adaptation to wide range of soils and climate, shorter duration, ability to withstand salinity, water logging and drought and also due to their exceptional nutritional profile. Millets are also known as 'famine reserves' due to their prolonged shelf life of more than two years without deterioration (Sahu and Sharma, 2013) [12]. Finger millet (*Eleusine coracana* L.) is cultivated in the tropical and subtropical regions, has been reported to thrive on hardly 28 per cent of the water requirement of rice (Triveni *et al.*, 2017) [14].

Pulses help in the maintenance of soil fertility by virtue of their ability to fix atmospheric nitrogen. Pulses have been reported to fix 72 to 350 kg N ha year (Tiwari and Shivhare, 2016) [15]. Thus, pulses play a pivotal role in sustainable agriculture. The pulses provide significant nutritional and wellness benefits, and are recognized as to reduce several serious diseases such as cardiovascular diseases and colon cancer (Jukanti *et al.*, 2012) [7].

Crop diversification through intercropping has been acknowledged as a principal pillar for ensuring sustainable development. Crops which vary in their growth habits are grown together so that they complement one another resulting in higher resource use efficiency. Legumes assume paramount importance in intercropping systems involving cereals / millets because of their ability to fix and transfer nitrogen. Sole cropping of millets like finger millet is usually not appreciably remunerative and it fails to satisfy the diverse consumer demand. The initial slow growth phase of finger millet can be utilized for raising short duration pulses. Moreover, intercropping with fast growing pulses will also help in reducing the weed problems.

Materials and Methods
The experiment was conducted to know the Effect of intercropping with pulses on growth and yield of finger millet (*Eleusine coracana* L.) was carried out at Crop Research Farm of Sam

Higginbottom University, Prayagraj, Uttar Pradesh. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.4), low in organic carbon (0.51%), available N (78.9 kg/ha), available P (32.88 kg/ha) and available K (385.10 kg/ha). The experiment was laid out in Randomized Block Design with thirteen treatments including control each replicated thrice. The treatments consists of T_1: Finger millet + Cowpea (2:1 ratio), T_2: Finger millet + Cowpea (4:1 ratio), T_3: Finger millet + Cowpea (6:1 ratio), T_4: Finger millet + Black gram (2:1 ratio), T_5: Finger millet + Black gram (4:1 ratio), T_6: Finger millet + Black gram (6:1 ratio), T_7: Finger millet + Green gram (2:1 ratio), T_8: Finger millet + Green gram (4:1 ratio), T_9: Finger millet + Green gram (6:1 ratio), T_{10}: Finger millet (sole), T_{11}: Cowpea (sole), T_{12}: Black gram (sole) and T_{13}: Green gram (sole) with recommended doses of nitrogen, phosphorus and potassium (60-30-30 kg N-P-K/ha). The Finger millet seeds were sown at a spacing of 30 cm row to row and 10 cm plant to plant. The growth contributing characteristic such plant height, plant dry weight, number of tillers per running meter and yield contributing characters such as the number of fingers per plant, number of grains per earhead, test weight, grain yield (kg/ha), straw yield (kg/ha) and land equivalent ratio were recorded at the time of harvest. The collected data was subjected to statistical analysis by analysis of variance method.

Results and Discussion

Growth Parameters

At 80 DAS, significantly maximum plant height (94.70 cm) was recorded in sole plot of finger millet (treatment 10). However, plant height of finger millet when intercropped with black gram in 2:1 ratio (treatment 4) is statistically at par with sole plot of finger millet. All the growth attributes of finger millet were superior under sole cropping reported by Kumar and Ray (2020) [9].

Maximum plant dry weight (19.49 g/plant) was recorded when finger millet was intercropped with black gram in 2:1 ratio (treatment 4) and the plant dry weight of finger millet when intercropped with green gram in 2:1 ratio (treatment 7) was recorded to be statistically at par. Kiroriwal and Yadav (2013) [8] observed higher dry matter accumulation in finger millet + black gram intercropping system than sole crop of finger millet and attributed it to the weed suppressing ability of intercropping than monocropping.

The number of tillers per running row was significantly more (8.50 cm) was recorded when finger millet was intercropped with black gram in 6:1 ratio (treatment 6). However, number of tillers per running row was observed to be statistically at par when finger millet was intercropped with green gram in 6:1 ratio (treatment 9). Among the intercropping systems tested, finger millet + black gram in 6:2 ratio recorded taller plants with more number of tillers per hill reported by Kumar and Ray (2020) [9].

Yield Parameters

At 80 DAS, significantly maximum number of fingers/plant was recorded when finger millet was intercropped with green gram in 6:1 ratio (5.86), which was significantly higher over all the treatments and statistically at par to the treatment 6 where finger millet was intercropped with black gram in 6:1 ratio.

Significantly more number of grains/earhead was recorded where finger millet was intercropped with black gram in 6:1 ratio (1809.06) and statistically at par treatment was where finger millet was intercropped with cowpea in 6:1 ratio. Both sole cropping and intercropping had no significant effect on the test weight of finger millet. The lack of variation in the thousand grain weight or test weight might be due to the fact that test weight is a prime yield determinant, which has been identified as a genetic character of crops least affected by the environment (Ashraf *et al.*, 1999) [2].

Grain yield (1532.88 kg/ha) and straw yield (3216.50 kg/ha) was significantly high when finger millet was intercropped with green gram in 6:1 ratio (Treatment 9) and was statistically at par when finger millet was intercropped with black gram in 6:1 ratio (treatment 6).

Land Equivalent Ratio (LER)

The highest LER (1.68) was recorded when finger millet was intercropped with green gram in 6:1 ratio (treatment 9). Whereas, finger millet intercropped with green gram in 4:1 ratio (treatment 8) was found to be statistically at par.

Higher LER of intercropping with pulses compared to sole cropping has been reported by Jabbar *et al.* (2009) [6] in direct seeded rice and by Dass and Sudhishri (2010) in finger millet.

Table 1: Effect of intercropping with pulses on growth attributes of Finger millet

		80 DAS		
S. No	**Treatment combination**	**Plant height (cm)**	**Plant dry weight (g/plant)**	**Number of tillers/running row**
1.	Finger millet + Cowpea (2:1 ratio)	92.39	19.40	6.50
2.	Finger millet + Cowpea (4:1 ratio)	91.12	19.13	7.36
3.	Finger millet + Cowpea (6:1 ratio)	89.02	18.47	8.13
4.	Finger millet + Black gram (2:1 ratio)	92.73	19.49	7.26
5.	Finger millet + Black gram (4:1 ratio)	92.27	19.16	7.66
6.	Finger millet + Black gram (6:1 ratio)	90.68	18.84	8.50
7.	Finger millet + Green gram (2:1 ratio)	92.25	19.44	7.26
8.	Finger millet + Green gram (4:1 ratio)	91.46	19.15	7.56
9.	Finger millet + Green gram (6:1 ratio)	90.26	18.78	8.20
10.	Finger millet (sole)	94.70	18.86	7.80
	SEm(±)	0.295	0.088	0.041
	CD (p=0.05)	0.879	0.264	0.122

Table 2: Effect of intercropping with Pulses on yield attributes of Finger millet

S. No.	Treatment combination	Number of Fingers/Plant	Number of Grains/earhead	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
1.	Finger millet + Cowpea (2:1 ratio)	4.13	1778.13	2.66	1161.76	2668.96
2.	Finger millet + Cowpea (4:1 ratio)	5.06	1789.40	2.83	1248.80	2685.88
3.	Finger millet + Cowpea (6:1 ratio)	5.40	1808.40	2.84	1524.63	3177.13
4.	Finger millet + Black gram (2:1 ratio)	4.26	1788.40	2.86	1240.74	2719.69

5.	Finger millet + Black gram (4:1 ratio)	4.73	1786.86	2.87	1356.60	2843.30
6.	Finger millet + Black gram (6:1 ratio)	5.60	1792.86	2.91	1529.93	3189.62
7.	Finger millet + Green gram (2:1 ratio)	4.40	1809.06	2.89	1238.66	2713.65
8.	Finger millet + Green gram (4:1 ratio)	5.46	1789.66	2.91	1372.40	2910.06
9.	Finger millet + Green gram (6:1 ratio)	5.86	1787.33	2.81	1532.88	3216.50
10.	Finger millet (sole)	5.66	1779.60	2.87	1634.73	3405.36
	S.Em(±)	0.106	5.852	0.052	10.13	27.529
	CD (p=0.05)	0.315	17.388	-	30.11	81.794

Table 3: Effect of intercropping on Land Equivalent Ratio (LER)

S. No.	Treatment combination	Land Equivalent Ratio (LER)
1.	Finger millet + Cowpea (2:1 ratio)	1.46
2.	Finger millet + Cowpea (4:1 ratio)	1.47
3.	Finger millet + Cowpea (6:1 ratio)	1.62
4.	Finger millet + Black gram (2:1 ratio)	1.60
5.	Finger millet + Black gram (4:1 ratio)	1.64
6.	Finger millet + Black gram (6:1 ratio)	1.60
7.	Finger millet + Green gram (2:1 ratio)	1.62
8.	Finger millet + Green gram (4:1 ratio)	1.66
9.	Finger millet + Green gram (6:1 ratio)	1.68
10.	Finger millet (sole)	-
	SEm(±)	0.025
	CD (p=0.05)	0.075

Conclusion

It can be concluded that intercropping black gram with finger millet in 2:1 ratio (Treatment 4) recorded highest plant height and maximum plant dry weight. Whereas intercropping black gram with finger millet in 6:1 ratio (Treatment 6) recorded a highest number of tillers. Fingers/plant, grain yield, straw yield and land equivalent ratio was recorded high when green gram was intercropped with finger millet in 6:1 ratio (treatment 9)

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Competing Interests

Authors have declared that no competing interests exist.

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