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PRODUCTIVITY OF MULTICUT SORGHUM AND PEARL MILLET MIXTURE AS INFLUENCED BY SEEDING RATIOS UNDER DIFFERENT METHODS OF SOWING

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SUMMARY

A field experiment was conducted in the fodder research farm of Department of Plant Breeding and Genetics, PAU Ludhiana during three consecutive *Kharif* seasons from 2015-2017 to study the production potential of multicut sorghum sown with pearl millet in different seeding ratios under different methods of sowing. The experiment was planned comprising of ten treatment combinations *i.e.* five seeding ratios of sorghum and pearl millet (100:0, 75:25, 50:50, 25:75 and 0:100) and two methods of sowing (line sowing and broadcast sowing). The green fodder and dry matter yield increased in intercrops than the sole crops. The results of the study confirmed the superiority of seeding ratio of 25:75 of sorghum and pearl millet in total green fodder yield (728.3 q/ha) over other treatments. However, highest dry matter yield was recorded by the sole stand of pearl millet crop followed by the seeding ratio of 25:75. The nutritive value of pearl millet (7.36% crude protein content) was better than sorghum (6.74% crude protein) and hence the crude protein content of the intercropping treatments increased with increase in the seeding ratio of pearl millet. The growth and yield of crops whether in sole stand or in intercropping was better with line sowing over broadcast sowing. The fodder quality was not affected by the method of sowing. Line sowing realized higher net returns of Rs 34416/ha and among the seeding ratios higher net returns was achieved by 25:75 seeding ratio.

Key words : Sorghum, pearl millet, intercropping, quality

Livestock comprises an important component of the agrarian rural India and livestock rearing provides considerable employment opportunities and enhance the family income of Indian farmers by contributing approximately 21% in the total agricultural income of the family (Sharma et al, 2009). The success of livestock industry hugely depends on the supply of quality rich green fodders. Among the *kharif* fodders being grown in Punjab, sorghum and pearl millet are very important crops providing green palatable and nutritious fodder for cattle ensuring good milk yield. Further, both these fodder crops are adaptable to low fertility soils and limiting soil moisture conditions making these crops ideal for arid and semi-arid regions. While, sorghum has wider adaptability and more widely grown whereas pearlmillet uses less water for per unit production of fodder. Their high tillering ability, high dry matter production, high protein content (10-12 %) with excellent growth habit, high palatability and better nutritive value make these two fodder crops indispensable in tropical areas providing food, feed and fuel to millions of poor farmer families and their livestock (Harinarayana et al, 2001). Mostly these two crops are grown as pure but now farmers have started growing these two fodder crops as mixture to have more forage production due to their differential growth and regeneration capacity. The development of multi-cut varieties/hybrids of sorghum and pearl millet has further drove forage growers to cultivate these crops in mixture since it assures them much higher yields in short period and saving in cost of cultivation in terms of seed and land preparation. Mixed cropping of fodder crops is particularly popular among small land holding farmers. However, the forage growers are doing mixed cropping of sorghum and pearl millet using their indigenous knowhow adjusting seeding ratio/rate of individual crops by rule of thumb. Thus, they are not properly following the rules of mixed cropping so they are not able to get stable yields and profits. This calls for relevant research in the system to improve the

productivity of component crops. Hence, there is a need to identify and recommend the appropriate seeding ratio of sorghum and pearl millet in a mixed cropping system to get higher forage yields. Further, most of the farmers opt broadcast sowing of fodder crops due to the ease of operation. However, superiority of line sowing over broadcast sowing has been documented in many crops due to uniform placement of the seed. Therefore, the present study was planned with the objective to investigate the suitable seeding ratio of sorghum and pearl millet in mixed cropping as well as suitable method of sowing for higher yields and economic gains.

MATERIALS AND METHODS

A field experiment was conducted for three consecutive *Kharif* seasons *i.e.* 2015 to 2017 at the research farm of Forage and Millet Section, Department of Plant Breeding and Genetics, PAU, Ludhiana to find out the optimum seeding ratio of sorghum and pearl millet and suitable method of sowing of these fodder crops in mixed cropping. The experimental site is situated at 30°54′N latitude and 75°48′E longitude with an altitude of 247 meters above the mean sea level. The texture of the experimental soil was sandy loam with pH 7.8, low in available nitrogen 184 kg/ha, low in available phosphorus 16.8 kg/ha and high in available potassium 246 kg/ha. The experiment was laid out in factorial randomized completely block design and each treatment combination was replicated thrice. The experimental unit plot size was 3.6m × 5 m. The ten treatment combinations comprised of five seeding ratios of sorghum and pearl millet (100:0, 75:25, 50:50, 25:75 and 0:100) and two methods of sowing (line sowing and broadcast sowing). The proportion of seed indicates per cent amount of recommended seed rate of each crop. The recommended seed rate used was 40 and 20 kg/ha for sorghum and pearl millet, respectively. The sorghum multi-cut variety 'PSC-4' and pearl millet variety 'FBC 16' was used for sowing in the experiment. The crop was sown around mid June of every year in a well prepared seedbed using the amount of seed of each crop as per treatment and as per the method of sowing. The crops were fertilized with 100, 20 and 25 kg/ha of nitrogen, phosphorus and potassium through urea, single super phosphate and muriate of potash, respectively. Half dose of nitrogen and full dose of phosphorus and potash were applied at the time sowing as basal dose. Remaining half dose of nitrogen was top-dressed after first irrigation at crop knee height stage. An equal amount of nitrogen *i.e.* 100 kg/ha was broadcast after first cut. Other standard agronomic and plant protection practices were followed to successfully raise the crops. The first cut was taken at about 65 days after sowing and the second cut was taken at 50% flowering stage. The data on green fodder yield and yield attributes was recorded at each cut. Plant samples collected at each cut were sun dried followed by overnight drying in hot air oven for dry matter estimation. Plant samples were also collected at each cut for CP analysis (AOAC, 2005). The data were analyzed by using computer software programme 'OPSTAT' available on CCS Haryana Agricultural University website (Sheoran et al, 1998). The results are presented at five per cent level of significance (P=0.05) for making comparison between treatments.

RESULTS AND DISCUSSION

The plant height of sorghum in both the cuts was influenced significantly by the different seeding ratios (Table 1). At first cut, the plant height of sorghum was significantly highest in 25:75 seeding ratio but was statistically at par with 50:50 seeding ratio. Sorghum crop grown in sole stand as well as in 75:25 seeding ratio recorded statistically similar plant height. Increase in competition effect with increase in seeding proportion of pearl millet might have affected sorghum plants which tended to grow taller as compared to sorghum. Similar effect on plant height of sorghum crop was noticed in the second cut. The variable interaction and competition effect among crops resulted in the variable plant height of pearl millet in both the cuts. In second cut, the plant height of sorghum was less as compared to that in the first cut while reverse trend was observed for pearl millet. The slow regeneration of sorghum in the second cut as well as due to its less competitive ability compared to pearl millet, it failed to exhibit any significant competition with pearl millet, hence no significant effect of seeding ratios on plant height of pearl millet was observed. A reduction in plant height of maize in maize+cowpea intercropping at higher seed rate of cowpea was noticed by Babu et al (1994). The plant height of both sorghum and pearl millet was found to be significantly more with line sowing than broadcasting in both the cuts. Significant differences for plant height under different sowing methods have also been reported by Ayub et al 1998 and Ashraf et al 1995.

TABLE 1
Effect of seeding ratios of crops and methods of sowing on growth of sorghum and pearl millet crops in first and second cuts

Treatments	First cut				Second cut			
	Plant height of sorghum (cm)	Plant height of bajra (cm)	Tillers/m^2 of sorghum	Tillers/m^2 of bajra	Plant height of sorghum (cm)	Plant height of bajra (cm)	Tillers/m^2 of sorghum	Tillers/m^2 of bajra
Seeding ratio								
Sorghum: bajra (100:0)	125.0	-	62.8	-	111.7	-	38.8	-
Sorghum: bajra (75:25)	126.0	157.1	53.4	84.7	115.1	165.4	30.1	71.8
Sorghum: bajra (50:50)	133.8	160.0	47.8	104.2	130.4	165.5	27.1	76.9
Sorghum: bajra (25:75)	139.1	155.6	46.1	123.8	134.9	166.3	22.5	93.0
Sorghum: bajra (0:100)	-	155.1	-	131.5	-	167.3	-	99.5
CD (p=0.05)	5.74	NS	5.99	10.90	6.29	NS	3.43	9.70
Method of sowing								
Line sowing	138.4	165.1	60.7	121.2	127.9	172.6	32.1	93.6
Broadcasting	123.5	148.9	44.4	100.8	118.1	159.6	27.2	76.9
CD (p=0.05)	4.06	3.85	4.24	7.71	4.45	3.16	2.43	6.85

The data in Table 1 revealed that tiller number per m^2 of sorghum decreased with increasing seeding ratio of pearl millet in both the cuts. Sole sorghum produced significantly highest tiller number as compared to all treatments of mixed cropping. Similarly, significantly more number of tillers of pearl millet was observed in its sole stand and thereafter a consistent and significant reduction in tiller count was recorded with every reduction in the seeding ratio of pearl millet in the mixed cropping. The trend in tiller number of both the crops is in accordance with the amount of seed of respective crop used for sowing in each treatment. Both the crops recorded significant increase in tiller numbers in both the cuts in line sowing compared to broadcast sowing which is due to better crop growth.

The effect of different treatments on green fodder yield is presented in Figs. 1-3. The general trend in the mixed cropping experiment was that the green fodder yield of the mixture was more than the fodder yields of the two component crops grown alone. The differences between different seeding ratios of sorghum and pearl millet used in the present study were found to be statistically non-significant in both the cuts as well as total of the two cuts. However, it was found that sowing of sorghum and pearl millet in 25:75 seeding ratio produced highest total green fodder yield of 728.3 q/ha. It was closely followed by the seeding ratio of 50:50 of sorghum and pearl millet. The lowest green fodder yield was recorded by sole sorghum followed by the seeding ratio of 75:25 of sorghum and pearl millet. Due to reduction in regeneration capacity of the two crops, a reduction in green fodder yield was registered in second cut in

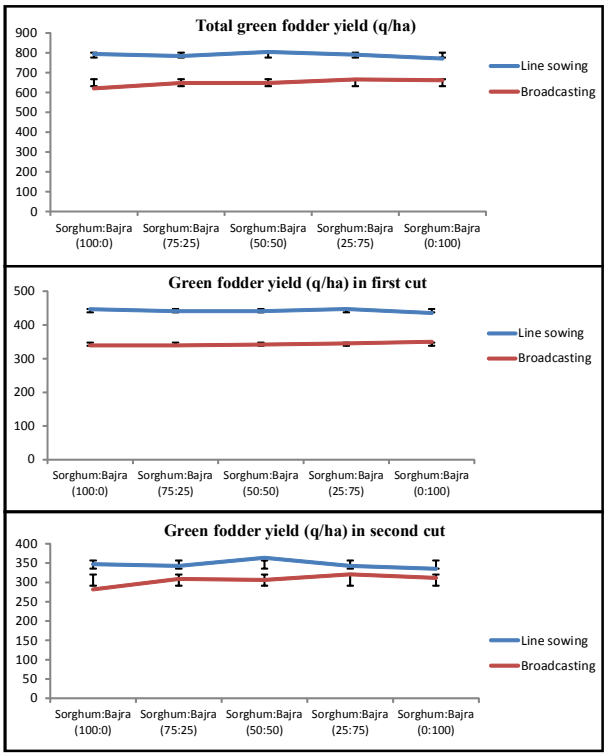

Fig. 1-3. Effect of seeding ratios and methods of sowing on green fodder yield of sorghum and pearl millet crops.

comparison to the first cut. A similar trend was noticed in dry matter yield in first and second cut, however in total of the two cuts, the dry matter yield was slightly more in sole pearl millet crop followed by the seeding ratio of 25:75 (Table 2). In fodder maize + guinea grass system, higher productivity was recorded by the intercropping treatment than the sole stand of each crop (Kumar and Ramawat, 2006).

Green fodder yield of the mixed cropping

TABLE 2
Effect of seeding ratios of crops and methods of sowing on dry matter and crude protein yields and economics of sorghum and pearl millet crops

Treatments	Dry matter yield (q/ha) in first cut	Dry matter yield (q/ha) in second cut	Total dry matter yield (q/ha)	Crude protein content (%)	Crude protein yield (q/ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Seeding ratio								
Sorghum: bajra (100:0)	69.9	62.4	132.3	6.74	8.91	49869	29049	2.37
Sorghum: bajra (75:25)	66.8	64.2	131.1	6.82	8.94	50355	29079	2.37
Sorghum: bajra (50:50)	68.4	65.4	133.8	6.84	9.15	50973	29994	2.42
Sorghum: bajra (25:75)	68.7	66.6	135.3	6.88	9.31	51010	29704	2.41
Sorghum: bajra (0:100)	92.1	64.6	136.7	7.36	10.06	50078	29037	2.38
CD (p=0.05)	NS	NS	NS	0.39	0.66	NS	NS	NS
Method of sowing								
Line sowing	78.4	69.0	147.4	6.99	10.12	55297	34416	2.65
Broadcasting	59.9	60.3	120.2	6.86	7.88	45617	24329	2.14
CD (p=0.05)	3.06	2.49	4.15	NS	0.42	1299	1299	0.06

system was significantly influenced by the method of sowing (Figs. 1-3). Owing to the uniform placement and distribution of seeds in the field, line sowing method recorded constantly higher green fodder yield and dry matter yields in both first and second cuts and in total of the cuts for both sole stands of the two crops as well as for different seeding ratios used. Further, in line sowing there is more efficient utilization of light, water resources and soil nutrients due to better spatial arrangement of the plants than in broadcast sowing. The reduction in yield in broadcast sowing could be attributed to more inter-plant competition because of non-uniform distribution of plants per unit area. There was an increase of 28.9, 13.2 and 21.5% in green fodder in first cut, second cut and total of the two cuts, respectively with line sowing as compared to broadcast sowing. Similarly, the dry matter yield was found to increase by 31, 14.4 and 22.6% in first cut, second cut and total of the two cuts, respectively with line sowing as compared to broadcast sowing. Earlier, Ayub and Shoaib (2009) also reported higher green fodder yield of sorghum in 30 cm apart rows than broadcast sowing of sole sorghum.

Significantly highest value of crude protein content of 7.36% was recorded by sole pearl millet crop as compared to all other treatments, whereas, lowest value of crude protein content was observed by sole sorghum crop. An increasing trend in crude protein content was noticed with every subsequent increase in the proportion of pearl millet in the mixed cropping treatments. Increasing seeding rate of pearl millet in the mixed cropping treatments might have resulted in an increase in the proportion of pearl millet in the green fodder which in turn affected the crude protein content in different treatments. Significantly highest crude protein yield of 10.38 q/ha was recorded by sole pearl millet which was 28.9, 22.3, 17.8 and 11.9 per cent more as compared to that recorded by sole sorghum, seeding rate of 75:25, 50:50 and 25:75 of sorghum and pearl millet, respectively. The higher crude protein yield of sole pearl millet is due to the highest total dry matter over all other treatments.

A perusal of the data revealed no significant effect of sowing methods on crude protein content of the fodder. Non-significant effect of method of sowing on crude protein content of fodder has similarly been reported by Dhar *et al.* (2006). The sowing method could not significantly affect the crude protein content but a significant effect of sowing methods on crude protein yield was recorded which could be accounted to the difference in the dry matter yield obtained in the respective treatments. Line sowing produced 28.4 per cent more crude protein yield over broadcast sowing.

The data on economics of the mixed cropping as affected by the seeding rates and method of sowing is given in Table 2. Although the differences among different seeding rates used for sowing of mixed cropping of sorghum and pearl millet were statistically non-significant, highest net returns of Rs 29994/ha were obtained by seeding rate of 25:75 of sorghum and pearl millet followed by the net returns of Rs 29704/ha obtained with the seeding rate of 50:50. Higher fodder yield in 25:75 seeding ratio lead to higher net returns making this treatment more profitable. Further highest benefit cost ratio of 2.42 was obtained by the seeding ratio of 25:75 of sorghum and pearl millet.

The data indicated higher net returns of Rs. 34416/ha in line sowing owing to production of higher green fodder yield in this method of sowing. Line sowing resulted in Rs 10087/ha more net returns over broadcast sowing of fodder crops.

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