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Original Research Article

Influence of Intercropping and Weed Control Measures on Yield Component and Nutrient Content of Pearl Millet [*Pennisetum glaucum* (L.) Br Emend Stuntz.]

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A B S T R A C T

This manuscript focused on the effect of intercropping and weed control measures on growth, yield component and nutrient content of pearl millet. Total dry matter at harvest, total number of tillers per plant and effective tillers per plant of pearl millet were significantly higher under intercropping with legume. Maximum grain yield (908 kg ha^{-1}) and straw yield (1718 kg ha^{-1}) of pearl millet were recorded with sole pearl millet over pearl millet based intercropping. Nitrogen content in grain and straw of pearl millet was increased significantly with crop grown with intercrop of cluster bean (6.40 and 6.70 %, respectively) and moth bean (5.42 and 7.87 %, respectively) compared to sole crop. The plant height, dry matter accumulation, effective tillers, ear head length, grain, straw and biological yield of pearl millet were increased significantly under all the weed control treatments(except imazethapyr at 40 g ha^{-1}) as compared to weedy check. Nitrogen, phosphorus and potassium content in grain and straw of pearl millet increased considerably with all weed control treatment compared to weedy check.

Keywords

Pearl millet, Intercropping, Weed control and Nutrient content

Introduction

Pearl millet [*Pennisetum glaucum* (L.) Br Emend stuntz.] popularly known as bajra is an important coarse grain cereal of Northwestern Rajasthan region. Pearl millet is the staple cereal in arid and semi - arid regions of country. It is the only cereal crop that is capable of producing a reliable yield under the marginal environments and simultaneously responds to high management conditions. Its nutritious grain forms the important component of human diet and stover forms the principal maintenance ration for ruminant during the dry season. In addition, pearl millet grain is increasingly being used as feed for livestock and poultry. Its grains contain 11-12% protein, 5-6% fat, 67% carbohydrate and are also rich in minerals (phosphorus and iron) and vitamins (carotene, riboflavin and niacin). India is the largest producer of pearl millet with an annual production of 10.05 m tons from an area of 8.69 m ha and productivity of 1156 kg ha^{-1} (Anonymous, 2014). Rajasthan ranks first in area (4.41 m ha) and production (4.11 m tons). However, average

productivity is 933 kg ha^{-1} which is still low compared to the national average. (Anonymous, 2014b). In Rajasthan, pearl millet cultivation is mainly confined to the arid (62% of total area) and semi-arid (12.60% of total area) regions.

Northwestern Rajasthan is characterized by drought prone, low soil fertility and high temperature situation where vegetation condition is primarily dependent on the unpredictable climatic conditions. Mixed cropping by virtue of its merits has traditionally been practiced as an insurance against aberrant weather conditions and natural calamities like droughts, which appear more frequently in this region. Crop-mixtures, in general, outperform monocultures both in terms of productivity and weed suppression but in order to ensure their benefits to be persistent and consistent through time, more scientific way-out in the form of intercropping needs to be evaluated by involving crops which are complimentary and compatible to each other. Pearl millet and legume intercropping system is promising for this region and legumes compatible with pearl millet as intercrops, are mainly cluster bean and moth bean. All the component crops of the system have their own importance in livelihood of farmers of the region. Weed infestation is considered as one of the most important constraint that limits yields in intercropping system. In pearl millet, weeds account for 16 to 94 per cent reduction in yield (Umrani *et al.*, 1980). Thus, weed control has become crucial for quality product and higher yields. Conventional methods of weed control being weather dependent, laborious, more time consuming and costly due to high cost of labour and mechanical means being less efficient in controlling weeds compare to use of herbicides, there is need to explore suitable herbicide (s), which may be effective and economically viable for both monoculture and intercropping and also information on control of weeds in pearl millet and legume intercropping system in arid zone is lacking, particularly on post emergence herbicidal weed control. So there is a need to test chemical as well as other methods of weed control for pearl millet and legume intercropping system.

Materials and Methods

A field experiment was conducted at the Instructional Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *kharif* 2014. The seed of the crops were sown @ 4 kg ha^{-1} of pearl millet in lines spaced as per treatments in sole cropping and intercropping. The sowing was done by "*kera*" method in open furrow on July 23, 2014.

Site description and field experiment

The study was conducted at the Instructional farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner (28.01^0N latitude and 73.22^0E longitude at an altitude of 234.70 meters above mean sea level). According to National Planning Commission, Bikaner falls under Agro-climatic zone XIV (Western Dry Region) of India. The lowest and highest values of maximum temperature of 31.3^oC and 42.2^oC were recorded in the 45^{th} and 28^{th} standard meteorological week, respectively. Likewise, the extreme values of minimum temperature (11.5 & 29.6^0C) were recorded in the 45^{th} and 24^{th} standard meteorological weeks, respectively. Crop received 427.9 mm of rainfall in 12 rainy days in the growing season.

Soil samples were taken randomly from 0-15 cm depth from different spots of the experimental field and a representative composite sample was prepared by mixing all these samples together for analyzed to determine the mechanical composition,

physio-chemical properties, organic carbon and available N, P and K of the soil. Some of the initial soil properties were: the soil pH (1:2, soil: water) 8.50; Organic carbon (0.08 %) Walkley and Black's rapid titration method (Jackson, 1973); 86.40 kg ha^{-1} available nitrogen (Subbiah and Asija, 1956); 21.91 P_2O_5 kg ha^{-1} available phosphorus (Olsen *et al.,* 1954); 234.00 K_2O kg ha^{-1} available potassium (Jackson, 1973).

Experimental design and treatments

The experiment was laid out in a split plot design and replicated thrice. Five intercropping treatments as main plot comprised (i) Sole pearl millet, (ii) Sole cluster bean, (iii) Sole moth bean, (iv) Pearl millet + cluster bean (v) Pearl millet + moth bean. Four weed control treatments in sub plot comprised (i) Weedy check (remained infested till harvest), (ii) Hand weeding twice at 20 and 35 DAS, (iii) Pendimethalin at 0.75 kg ha^{-1} as pre emergence, (iv) imazethapyr 40 g ha^{-1} as post emergence. Full dose of phosphorus and half dose of nitrogen was applied as basal. The remaining half dose of nitrogen was applied as top dressing at 30 DAS through urea in rows of pearl millet only. Hoeing and weeding was done manually as per treatment. Two irrigations were applied to the crop during the dry spell. Various growth and yield parameters were observed at harvest following the standard procedure.

Statistical analysis

The data on growth, yield and other characters were statistically analyzed with the help of fisher's analysis of variance technique (Fisher, 1950). The critical difference (CD) for the treatment comparisons was worked out where ever the variance ratio (F test) was found significant at 5% level of probability. To evaluate the nature and magnitude at treatment effect, summary tables along with S.Em.± and critical difference (C.D.) were prepared.

Results and Discussion

Intercropping

The plant stand at 30 DAS and at harvest was significantly higher in pearl millet sole as compared to pearl millet intercrop with cluster bean as well as moth bean. Significant difference of plant stand among systems of intercropping was mainly by the virtue of the row ratio of intercropping system. Yadav and Jat (2005) reported similar results. At harvest dry matter production by pearl millet in intercropping system increased considerably. Pearl millet + cluster bean and pearl millet + moth bean intercropping increase 19.26 and 20.80 percent dry matter, respectively, over crop grown in sole. Better growth of pearl millet in intercropping systems might be due to the nitrogen made available from the intercrops is simultaneously used by the companion graminaceous crop at later stages (Chatterjee *et al.,* 1989) and also the short duration of intercrops, they did not compete for the environmental factors, like sunlight and space which show greater compatibilities with pearl millet might be the reason for better growth of pearl millet in different intercropping systems. Total number of tillers and effective tillers per plant of pearl millet were significantly higher under intercropping system either with cluster bean or moth bean as compared to sole pearl millet. Higher number of effective tillers in intercropping treatments may be due to lower pearl millet population and wider space available for more growth and development of pearl millet (Pal *et al.,* 2000). Singh and Agrawal (2004) also reported the similar findings under intercropping systems. Grain and straw yield of pearl millet increased considerably in pearl millet sole as compared to both

intercropping system with cluster bean and moth bean. Sole crop increased by 58.12 and 58.39 per cent grain yield of pearl millet compared to pearl millet – cluster bean and pearl millet – moth bean cropping system, respectively. Significant difference by intercropping system in grain, straw and biological yield of pearl millet were due to the virtue of the row ratio of intercropping system. These findings are in close conformity of those reported by Patel and Sadhu (2013) & Yadav and Yadav (2000). Nitrogen content in pearl millet grain and straw was increased significantly in crop grown with intercropping systems compared to sole crop. Pearl millet intercropped with cluster bean and moth bean increased nitrogen content of seed of pearl millet to the tune 6.40 and 5.42 per cent, respectively over sole crop of pearl millet. Increase in nitrogen content due to intercrops may be attributed to leguminous nature of the crops, which caused fixation of atmospheric nitrogen and release during growth. The aspect of this availability of nitrogen from the intercrops are simultaneously used by the companion graminaceous crop so benefited to companion crop. These results are in accordance with Sharma *et al.*, (2008). Phosphorus and potassium content in grain and straw of pearl millet were not influenced significantly by intercropping systems as well as sole crop.

Table.1 Effect of weed control measures and pearl millet legumes intercropping system on plant stand, plant height, dry matter accumulation, tillers and yield of pearl millet

Treatments	Plant stand ('000 ha^{-1})		Plant height (cm)		Dry matter accumulation (g plant^{-1})		Total tillers per plant	Effective tillers per plant	Yield (kg ha^{-1})	
	30 DAS	At Harvest	30 DAS	At Harvest	30 DAS	At Harvest			Grain	Straw
Intercropping										
Pearl millet sole	211	204	42.30	163.10	10.04	25.94	2.23	1.75	908	1718
Cluster bean sole	-	-	-	-	-	-	-	-	-	-
Moth bean sole	-	-	-	-	-	-	-	-	-	-
PM+CB (1:2)	70	69	40.57	161.73	9.86	30.84	2.82	2.26	380	664
PM+MB (1:2)	69	68	40.07	161.48	9.73	31.23	3.02	2.25	378	680
S.Em.±	2.5	2.7	0.94	2.96	0.53	1.22	0.14	0.11	20.5	57.4
CD (*P*=0.05)	10	11	NS	NS	NS	NS	0.53	0.43	80	225
Weed control										
Weedy check	134	125	44.28	157.99	10.91	26.80	2.28	1.64	500	987
Two hand weeding at 20 and 35 DAS	137	135	45.20	173.58	12.28	35.03	3.37	2.84	654	1237
Pendimethalin 0.75 kg ha^{-1} as PE	123	121	42.50	168.01	9.76	31.97	2.97	2.43	569	1067
Imazethapyr 40 g ha^{-1} at 25 DAS as PoE	73	71	31.93	148.83	6.56	23.56	2.14	1.42	497	790
S.Em.±	2.1	1.9	1.03	2.61	0.59	1.07	0.13	0.09	23.3	35.4
CD (*P*=0.05)	6	6	3.06	7.76	1.74	3.19	0.39	0.26	69	105

Table.2 Effect of weed control measures and pearl millet legumes intercropping system on nitrogen, phosphorus, potassium and protein content in pearl millet

Treatments	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Intercropping						
Pearl millet sole	1.624	0.455	0.266	0.117	0.573	1.846
Cluster bean sole	-	-	-	-	-	-
Moth bean sole	-	-	-	-	-	-
PM+CB (1:2)	1.728	0.486	0.269	0.120	0.586	1.851
PM+MB (1:2)	1.712	0.491	0.271	0.122	0.586	1.852
S.Em.±	0.021	0.006	0.003	0.001	0.008	0.025
CD (*P*=0.05)	0.083	0.024	NS	NS	NS	NS
Weed control						
Weedy check	1.517	0.406	0.257	0.114	0.564	1.804
Two hand weeding at 20 and 35 DAS	1.758	0.510	0.275	0.123	0.593	1.899
Pendimethalin 0.75 kg ha^{-1} as PE	1.745	0.498	0.271	0.120	0.584	1.850
Imazethapyr 40 g ha^{-1} at 25 DAS as PoE	1.729	0.496	0.271	0.122	0.585	1.847
S.Em.±	0.019	0.005	0.003	0.001	0.007	0.021
CD (*P*=0.05)	0.057	0.016	0.009	0.004	0.020	0.063

Weed control

The herbicidal weed control measures significantly reduced plant stand at 30 DAS as compared to weedy check and two hand weedings. Treatment comprising unweeded (Control), pendimethalin at 0.75 kg ha^{-1} and imazethapyr at 40 g ha^{-1} reduced plant stand of pearl millet by 7.37, 10.40 and 47.32 per cent at harvest, respectively over two hand weeding. All weed control measures (except imazethapyr at 40 g ha^{-1}) significantly increased plant height of pearl millet over weedy check at harvest. All weed control measures (except imazethapyr at 40 g ha^{-1}) considerably increased the crop dry matter production per plant of pearl millet over unweeded control. Hand weeding twice at 20 and 35 DAS recorded significantly higher dry matter production of pearl millet to the tune of 16.91, 48.73 and 30.72 per cent at harvest over, pendimethalin at 0.75 kg ha^{-1}, imazethapyr at 40 g ha^{-1} and weedy check, respectively. Hand weeding twice produced significantly higher total number of tillers and effective tillers per plant of pearl millet at harvest as compared to both pre and post emergence application of herbicides and weedy check. The all weed control measures (except imazethapyr at 40 g ha^{-1}) produced significantly higher grain and straw yield of pearl millet over weedy check.

Hand weeding twice at 20 and 35 DAS and pre emergence application of pendimethalin at 0.75 kg ha^{-1} recorded significantly higher grain yield of pearl millet to the tune of 30.76, and 13.71 per cent over weedy check, respectively. The weed control treatments brought significant effects on crop growth in terms of periodic plant stand, plant height and dry matter accumulation, total tillers, effective tillers and yield. Hand weeding twice significantly increased the grain and straw yield of pearl millet over other weed control measures. Two hand weedings recorded the highest grain while the lowest recorded under weedy check. The lowest straw and grain yield recorded in weed check plots may be ascribed to the maximum density and dry matter of weeds which compete with the crop plant. On the

other hand the higher grain yield obtained due to hand weeding treatment was associated with less weed competition and batter growth environment. Ram *et al.*, (2005) also reported improvement in yield components due to elimination of severe crop weed competition. Under herbicidal weed control treatments, although pendimethalin at 0.75 kg ha^{-1} and imazethapyr at 40 g ha^{-1} controlled the different type of weeds effectively but these treatments failed to produce higher yields due to some phytotoxic effect of pendimethalin at 0.75 kg ha^{-1} and imazethapyr at 40 g ha^{-1} on pearl millet so noticed. However, plant height was recouped at harvest. Similar results were also reported by Yadav *et al.,* (2004) in pearl millet in cumin - pearl millet cropping system. These results are also in accordance with the findings of Dan *et al.,* (2009) and Qian *et al.,* (2011). All the weed control treatments significantly increased nitrogen, phosphorus and potassium content in grain and straw of pearl millet over weedy check. Highest contents in grain and straw of pearl millet recorded under hand weeding twice being statistically at par with pendimethalin at 0.75 kg ha^{-1} and imazethapyr at 40 g ha^{-1}. Hand weeding twice effectively controlled the weed growth and provided almost weed free environment to the crop to utilize the available nutrients under reduced crop weed competition for nutrients, resulting in increased N, P and K content and crop dry matter production. Similar findings were also reported by Sreenivas and Satyanarayan (1994) and Ram *et al.*, (2004).

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