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EFFECT OF PLANT GEOMETRY AND WEED MANAGEMENT ON PRODUCTIVITY AND PROFITABILITY OF SUMMER PROSO MILLET

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ABSTRACT

A field experiment was conducted at Research Farm, Dholi of RPCAU during summer, 2024. The experiment was conducted in split block design and replicated thrice. Three different level of plant geometries were taken in main plot: S_1: 20 cm, S_2: 25 cm and S_3: 30 cm along with five levels of weed management practices taken in sub-plot: W_1: Pyrazosulfuron ethyl @ 25 g ha^{-1} at 20 DAS, W_2: Bispyribac sodium @ 25 g ha^{-1} at 20 DAS, W_3: 2-4, D @ 800 g ha^{-1} at 20 DAS, W_4: Two hand weeding at 20 and 40 DAS and W_5: weedy check. The experimental results revealed that closer spacing of S_1: 20 cm led to significantly higher plant height, number of tillers m^{-2}, crop growth rate and dry matter accumulation at different growth stages compared to wider spacings. However, wider spacing of S_3: 30 cm produced significantly higher number of panicles (5.91 $plant^{-1}$), panicle weight (1.05 g) and panicle length (27.69 cm) compared to narrow spacing. Among the weed management practices, two hand weeding at 20 and 40 DAS recorded significantly higher value of number of tillers m^{-2}, plant height, dry matter production, crop growth rate, panicle length (28.54 cm) and panicle weight as compared to rest of the treatments. However, it was statistically at par with treatment pyrazosulfuron ethyl @ 25 g ha^{-1} at 20 DAS and 2,4-D 800 @ g ha^{-1} at 20 DAS. Closer row spacing of S_1: 20 cm recorded significantly higher grain yield (19.66 q ha^{-1}) and straw yield (44.45 q ha^{-1}) with higher net return (55,225 ha^{-1}) and B: C ratio (1.66). Among the weed management practices, two hand weeding at 20 and 40 DAS recorded significantly higher grain yield (21.02 q ha^{-1}) and straw yield (45.39 q ha^{-1}) and lower weed population and weed dry matter but it was statistically similar to pyrazosulfuron ethyl @ 25 g ha^{-1} at 20 DAS. The net return (59,603 ha^{-1}) and B:C ratio (1.93) were significantly higher with pyrazosulfuron ethyl @ 25 g ha^{-1} at 20 DAS due to lesser cost of herbicides consumption compared to hand weeding.

Keywords **:** Proso millet, plant geometry, weed management, economics, yield.

Introduction

Proso millet comes under the group of small millets. Summer proso millet, commonly known as *Panicum miliaceum*, is an ancient cereal grain cultivated primarily in arid and semi-arid regions for its adaptability to dry conditions and short growing season. In India, small millets are grown in an area of 42.89 lakh ha with a production of 36.74 lakh tonnes production and productivity of 8.56 q ha^{-1}. In India, proso millet is grown in an area of 0.41 lakh ha with a production of 0.22 lakh tonnes and productivity of 5.32 q ha^{-1} (IIMR, 2017). It is largely cultivated in Rajasthan, Uttar Pradesh, Madhya Pradesh Tamil Nadu, Karnataka, and Bihar. In Bihar, fields remain vacant after harvesting of mustard/potato or short-duration rabi crops. If the farmers having irrigation

facility, then proso millet can be cultivated as a summer catch crop, offering a higher net return within a short growing period of around 60 to 80 days. The average productivity of small millets is less hence, there is need to develop proper agronomic practices for maximization of productivity (Upadhaya *et al*., 2022).

Optimum plant geometry and weed management are two important factors play's a significant role in suppressing weed growth, increase crop growth and yield. Spacing plays a significant role in maintaining plant population and contributing to better crop growth and yield. if lower spacing then there is severe competition among plants for light, moisture, space and nutrients as well as chances of disease incidence which leads to lower crop yield. So, ideal plant population is essential for obtaining higher yield. The most critical period for crop-weed competition is between 20 and 30 days after emergence. Manual weeding is a prominent method for weed management in proso millet, due to limited information regarding suitable herbicides. Hand weeding is costly and requires 25% of the total production cost and also shortages of labor during the critical period of crop weed competition is a measured concern. In this situation, application of chemical herbicide is more effective choice, which not only to reduce the cost of cultivation but also to control weeds timely (Degu *et al*., 2009).

Hence, there is a need to find the suitable herbicide for efficient and timely weed management and proper spacing to reduce the cost of cultivation and enhancing the productivity of proso millet in this region.

Materials and Methods

Field experiment was conducted during summer, 2024 at Research Farm, Dholi of Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar. Soil of the experimental plot was sandy loam in nature with pH 8.10, low in soil organic carbon (0.41%), available nitrogen (196 kg ha^{-1}) and available potassium (108 kg ha^{-1}) but medium in available phosphorus (21.64 kg ha^{-1}). The mean maximum and minimum temperature range during the crop season was 39.24^{0}C to 28.3^{0}C and 27^{0}C to 16^{0}C, respectively while mean maximum and minimum relative humidity range were 92.14% to 61% and 68.64% to 24.57%, respectively. The experiment was conducted in split plot design with three replications, comprising of three plant geometry in main plot S_1: 20 cm (row to row) S_2: 25 cm (row to row) and S_3: 30 cm (row to row) and five weed management treatment in sub plot W_1:Pyrazosulfuron ethyl @ 25 g ha^{-1} at 20 DAS (days after sowing), W_2: Bispyribac sodium @ 25 g ha^{-1} at 20 DAS (days after sowing), W_3: 2-4, D @ 800 g ha^{-1} at 20 DAS (days after sowing), W_4 :Two hand weeding at 20 and 40 DAS (days after sowing)and W_5: weedy check. Plant spacing within the row were maintained by thinning out excess plants at 20 DAS. As per the treatments, post-emergence herbicides were applied using a knapsack sprayer fitted with flat fan nozzle. To maintain weed-free plots, manual weeding was conducted twice at 20 DAS and 40 DAS using a *Khurpi*. Fine seedbed was prepared and seed were sown directly. BR 7 variety was used with a seed rate of 10 kg ha^{-1}. The recommended dose of fertilizer (40 kg N, 20 kg P_2O_5: 20 kg K_2O ha^{-1}) was applied to the crop. Full dose of phosphorus and potash with one third of nitrogen fertilizers were applied as basal and the remaining nitrogen was applied in two splits as top-dressing, one-third at active tillering and the remaining one-third at panicle initiation stage.

Results and Discussion

Effect of treatments on growth parameters

The result revealed that the growth parameters of proso millet *viz.,* plant height, number of tillers m^{-2}, and dry matter accumulation m^{-2} were significantly influenced by different spacing (Table 1, Fig. 1 & Fig. 2). Closer plant spacing of 20 cm consistently led to significantly higher plant height (66.08, 95.53, and 99.82 cm at 40, 60 DAS and harvest, respectively) compared to wider spacings of 25 cm and 30 cm except at 20 DAS. Plant height was higher in closer spacing which might be attributed due to the higher plant density per unit area, that restricted lateral growth and encourage vertical elongation or it might be due to increased competition for light. This result was in accordance with the findings of Singh *et al*. (2015). Fig.1 depicted that closer spacing of 20 cm recorded significantly higher number of tiller m^{-2} (114, 155, 249 and 235 at 20 40, 60 DAS and at harvest stage, respectively) as compared to wider spacing. It might be due to the increased number of plants per unit area, leading to greater overall tiller m^{-2}. These findings are in line with studies conducted by Rao *et al*. (2015). Fig.2 revealed that row spacing of 20 cm recorded significantly higher dry matter production m^{-2} (42.7,110, 507.16 and 807.83 g m^{-2} at 20, 40, 60 DAS and at harvest stage, respectively) than 30 cm, however, it was statistically at par with the 25 cm row spacing. Fig.3 showed that the closest row spacing of 20 cm resulted in higher crop growth rate (4.44, 9.18, and 5.31 g m^{-2} day^{-1}) compared to wider row spacings of 25 cm and 30 cm at 20-40 DAS, 40-60 DAS, and 60 DAS to harvest, respectively, except at 0-20 DAS. It might be due to increased plant population lead to

increased dry matter accumulation. The results are similar to the findings of Kumar *et al*. (2022).

Among the weed management practices, two hand weeding at 20 and 40 DAS was significantly superior over chemical weeding, achieving plant height of 69.36 cm, 97.68 cm, and 102.07 cm at 40 ,60 and at harvest, respectively (Table-1). However, it was statistically similar to Bispyribac sodium @ 25 g ha^{-1} and 2,4-D @ 800 g ha^{-1} at all the growth stages. Hand weeding at 20 and 40 DAS recorded significantly higher number of tillers m^{-2} (148, 264, and 249) at 40, 60 and at harvest stages, respectively, over rest of treatment but it was statistically at par with pyrazosulfuron ethyl @ 25 g ha^{-1} and 2,4-D @ 800 g ha^{-1} treatments at all the growth stages. Number of tillers m^{-2} was not significantly influenced by spacing and weed management practices at 20 DAS (Fig.1). Similar trend was also observed in respect to dry matter accumulation. This might be due to lower weed population and weed dry weight in these treatments. The finding is similar to Singh *et al*. (2016). Among weed management practices, hand weeding at 20 and 40 DAS achieved the highest crop growth rate of 4.52, 8.72 and 5.95g m^{-2} day^{-1} at 20-40 DAS, 40-60 DAS and 60 DAS to harvest, respectively (Fig.3). However, it was statistically at par with pyrazosulfuron-ethyl @ 25 g ha^{-1} during 20-40 DAS and 60 DAS to harvest.

Table 1: Effect of plant geometry and weed management on plant height of summer proso millet

Treatment	Plant height (cm)			
	20 DAS	40 DAS	60 DAS	Harvest
Spacing (S)				
S_1: 20 cm, (row to row)	20.75	66.08	95.53	99.82
S_2: 25 cm, (row to row)	21.40	62.19	89.53	93.95
S_3: 30 cm, (row to row)	21.55	60.28	87.16	91.08
SEm (±)	0.20	0.54	1.67	1.08
LSD (p=0.05)	NS	2.17	5.24	4.38
Weed management (W)				
W_1: Pyrazosulfuron ethyl @ 25 g ha^{-1} at 20 DAS	20.98	66.90	94.61	98.87
W_2: Bispyribac sodium @ 25 g ha^{-1} at 20 DAS	21.59	65.43	92.03	96.19
W_3: 2,4-D @ 800 g ha^{-1} at 20 DAS	21.67	62.28	89.74	93.78
W_4: Two hand weeding at 20 and 40 DAS	21.07	69.36	97.68	102.07
W_5: Weedy check	20.85	50.26	80.25	83.96
SEm (±)	0.506	1.60	2.87	3.07
LSD (P≤ 0.05)	NS	4.71	8.43	9.07

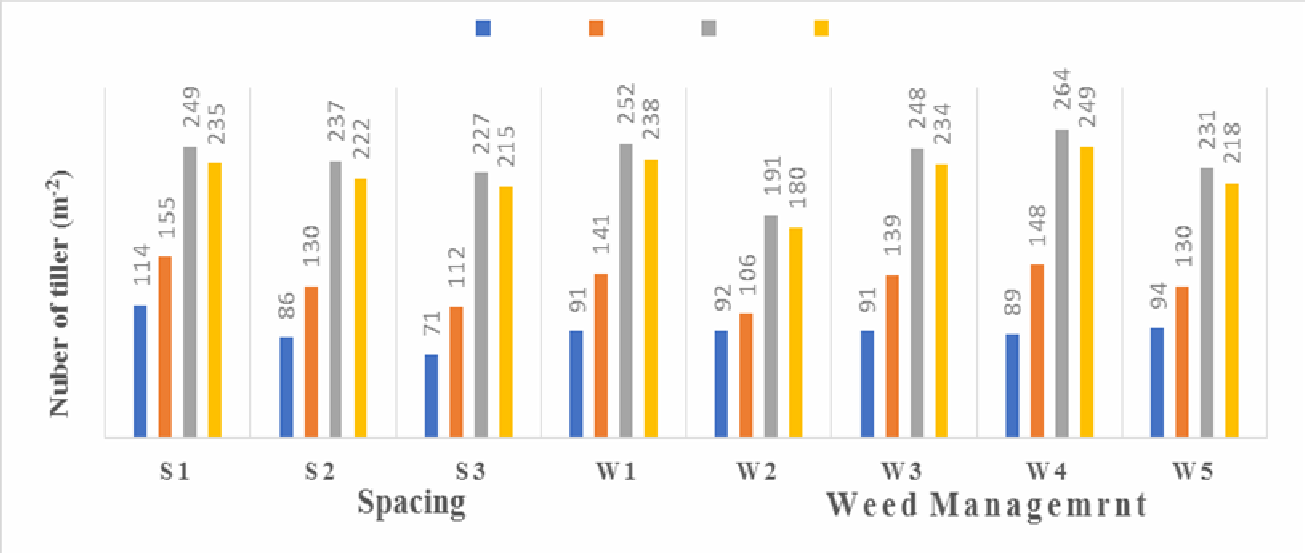

Fig. 1: Effect of plant geometry and weed management on number of tillers (m^{-2})

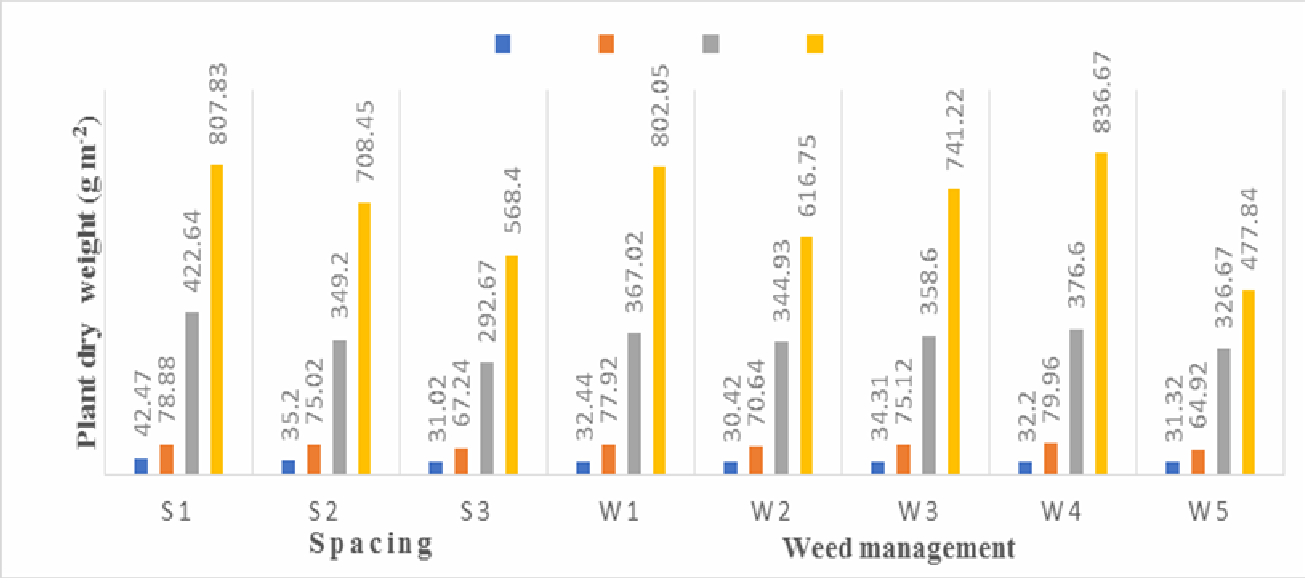

Fig. 2: Effect of plant geometry and weed management on plant dry weight

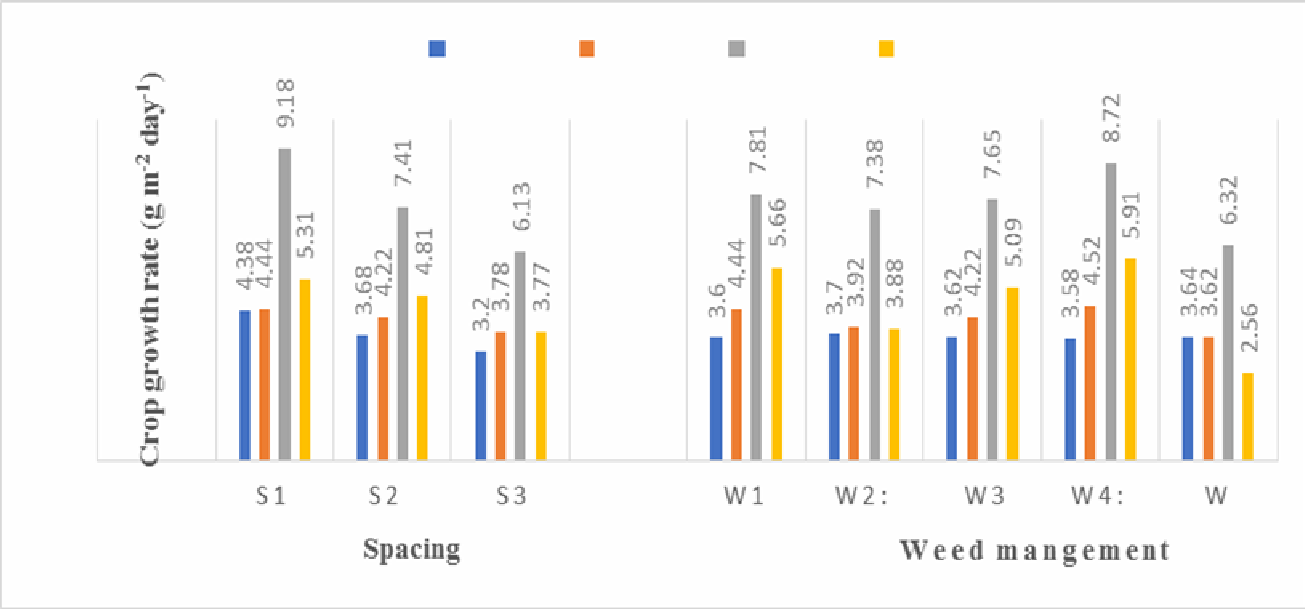

Fig. 3: Effect of plant geometry and weed management on crop growth rate

Effect of treatments on yield attributes

The yield-attributing characters *viz.*, number of panicles plant^{-1}, panicle length (cm) and weight of panicle (g) were significantly affected by plant geometry, but test weight (g) was unaffected by plant geometry (Fig-4). The wider row spacing of 30 cm recorded significantly higher panicle length (27.69 cm) than the closer spacing of 20 cm (24.50 cm) but it was statistically at par with 25 cm (26.64 cm). Wider spacing of 30 cm recorded significantly higher number of panicles per plant (5.91) as compared to 20 cm (5.17) but it was statistically at par with 25 cm spacing (5.58). This might be due to wider spacing provide more space to individual plant led to more availability of nutrient and moisture lead to increase all the yield attributes. Similar findings were reported by Singh *et al*. (2016). Test weight was not significantly affected by spacing and weed management practices.

Among the weed management yield attributes in proso millet, including the number of panicles per plant, panicle length and test weight were significantly affected by weed management practices. Hand weeding at 20 and 40 DAS recorded significantly higher panicle length (28.25 cm) compared to other treatments but it was statistically at par with Bispyribac sodium @ 25 g ha^{-1} (28.17) and Pyrazosulfuron ethyl

(25.93 cm). Similar trends were also observed in number of panicles per plant. Two hand weeding at 20 and 40 DAS recorded significantly higher weight of panicle (1.07 g) compared to other treatments but it was statistically at par with Pyrazosulfuron ethyl @ 25 g ha^{-1}. Test weight did not show significant variation among the different weed management practices. However, the number and length of panicles varied significantly depending on the chemical weeding treatments applied. The lower yield attributes were observed in weedy check plot which might be due to increased competition from weeds for resources that limits moisture and nutrient uptake by plants, thereby hindering plant growth.

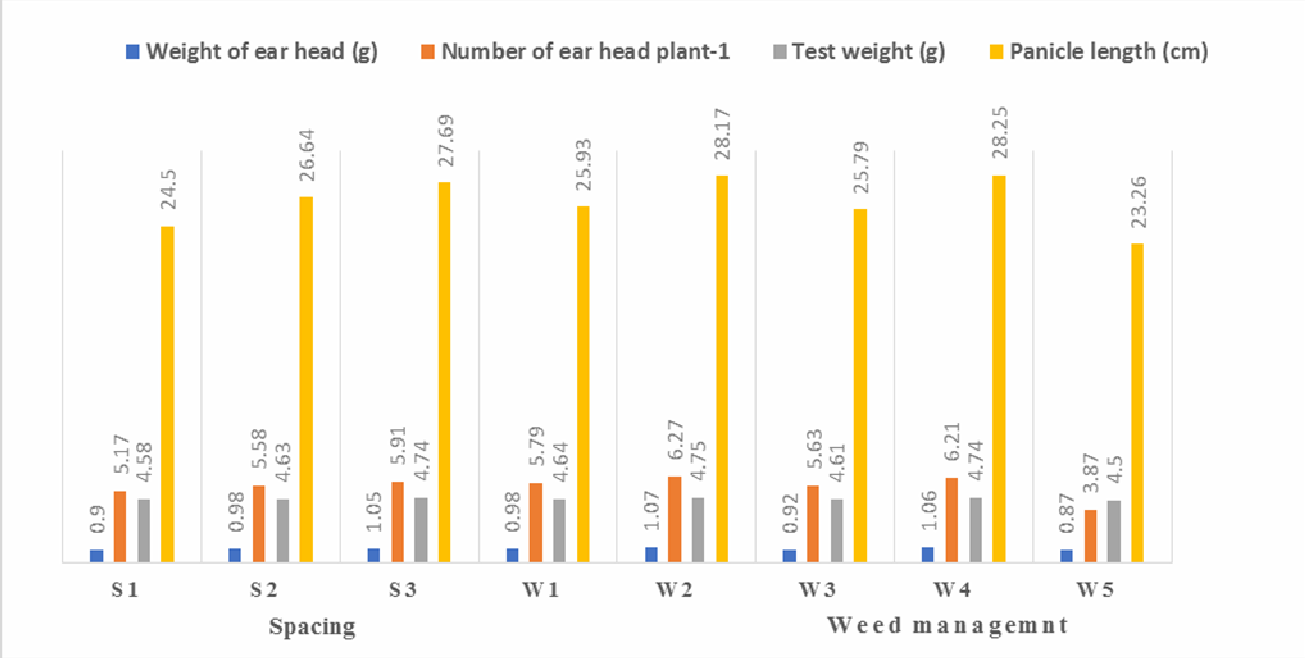

Fig. 4: Effect of plant geometry and weed management on yield attributes

Effect of treatments on grain yield and straw yield

The data revealed that grain and straw yields were significantly higher with closer row spacing (Fig.5). Spacing of 20 cm produced significantly higher grain yield (19.66 q ha^{-1}) and straw yield (44.45 q ha^{-1}) compared to wider spacings of 25 cm and 30 cm. The closer spacing of 20 cm allowed to grow more plants per unit area gave better utilization of resources such as light, water, and nutrients leading to higher yield. This aligns with the findings of Kumar *et al*. (2022) and Singh *et al*. (2016).

Weed management practices also significantly affected grain and straw yields compared to the control. In this study, the highest grain yield (21.02 q ha^{-1}) and straw yield (45.39 q ha^{-1}) were observed with two hand weedings (W_4), which were statistically similar to the treatment of Pyrazosulfuron ethyl @ 25 g ha^{-1}. Among the chemical treatments, Pyrazosulfuron ethyl @ 25 g ha^{-1} resulted in significantly higher grain and straw yield compared to other treatments but it was statistically at par with 2,4-D. The increase in grain and straw yields with weed control treatments is likely due to the maintenance of a weed-free environment during critical growth stages, reducing competition and promoting better crop growth and yield. These findings are supported by Ramadevi *et al*. (2021).

Effect of treatments on economics

Among the different plant spacings, the closer spacing of 20 cm resulted in significantly higher net returns (55,225 ha^{-1}) and benefit-cost ratio (1.66) compared to wider spacings (Table -2). In contrast, the widest spacing of 30 cm recorded the lowest value for economic indicators. The higher gross and net returns, along with a superior B:C ratio at the closer spacing, can be attributed to the greater production of both grain and straw, which led to increased economic returns. As row spacing widened, both grain and straw yields decreased, which directly lowered economic returns. Similar findings were also reported by Kumar *et al*. (2020).

Among weed management practices, the results showed that gross returns, net returns, and B: C ratio were significantly lower in untreated plots compared to those with weed control measures. Application of pyrazosulfuron ethyl @ 25 g ha^{-1} applied at 20 DAS

recorded significantly highest net return (Rs. 59,603 ha^{-1}) and B: C ratio (1.93) compared to other weed control methods. This might be due to its lower cost and effective weed control, whereas hand weeding, though increasing grain and straw yield, required more labor, increasing cost of cultivation and reducing net returns and B: C ratio. The findings are in consonance with the findings of Kumar *et al*. (2020) and Upadhaya *et al.* (2024).

Conclusion

Based on the study, it can be concluded that application of pyrazosulfuron ethyl @ 25 g ha^{-1} applied at 20 days after sowing at 20 cm row spacing was found to be the best option to control the weeds in summer proso millet for higher yield and profitability.

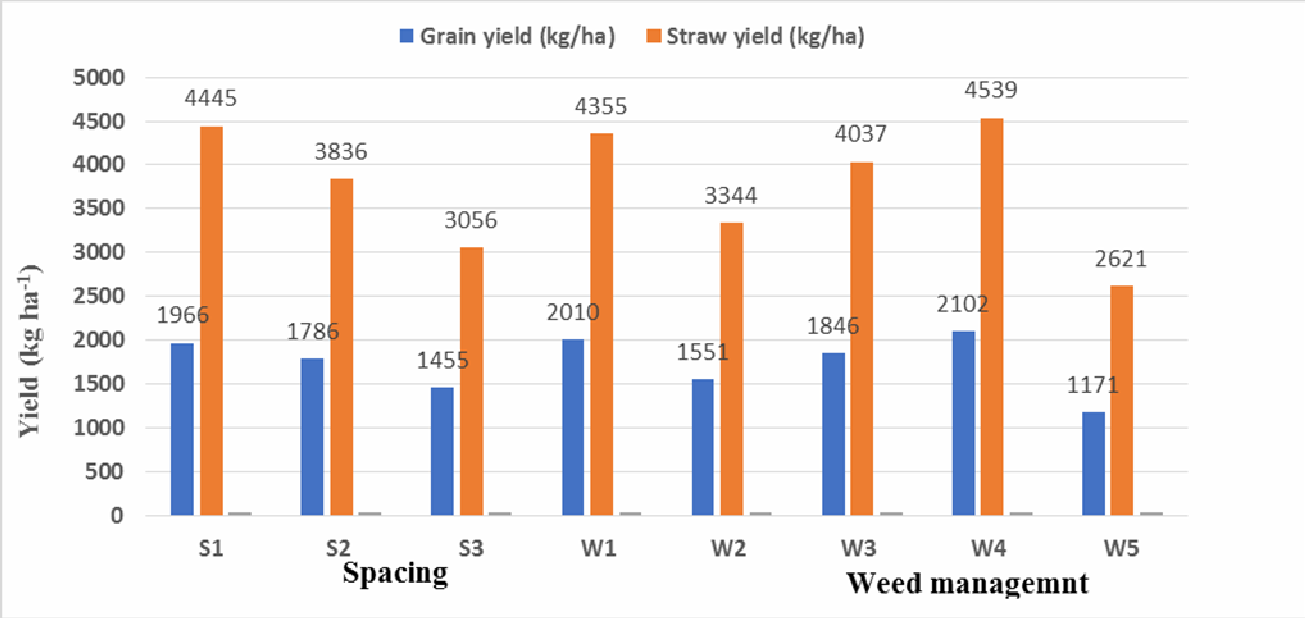

Fig. 5: Effect of plant geometry and weed management on grain and straw yield

Table 2: Effect of plant geometry and weed management on gross return, net return and B: C ratio

Treatment	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	Benefits: cost ratio
Spacing (S)			
S_1: 20 cm, (row to row)	88957	55225	1.66
S_2: 25 cm, (row to row)	80209	46668	1.42
S_3: 30 cm, (row to row)	65134	31699	0.97
SEm (±)	1415	1415	0.04
LSD (p=0.05)	5708	5708	0.17
Weed management (W)			
W_1: Pyrazosulfuron ethyl @ 25 g ha^{-1} at 20 DAS	90385	59603	1.93
W_2: bispyribac sodium @ 25 g ha^{-1}at 20 DAS	69665	38708	1.25
W3: 2,4-D @ 800g ha^{-1}@ 800 g ha^{-1} at 20 DAS	83109	52656	1.73
W_4: Hand weeding at 20 and 40 DAS	94449	47963	1.03
W_5: weedy check	52890	23724	0.81
SEm (±)	3067	3067	0.05
LSD (P≤ 0.05)	9006	9006	0.16

References

Degu, E., Adugna, A., Tadesse, T. and Tesso, T. 2009. Genetic resources, breeding and production of millets in Ethiopia. In new approaches to plant breeding of orphan crops in Africa. *Proceedings of an International Conference*, Bern, Switzerland 1921 September 2007

ICAR-AICRP on Small Millet (2017). Area, production, and productivity of proso millet in India Available at: https://apeda.gov.in/milletportal/Proso_Millet.html.

Kumar, A. and Singh, M. (2020). Benefit-Cost Analysis of Different Row Spacings in Millet Cultivation. *Indian Journal of Agronomy,* **65**(4), 350-358

Kumar, R., Singh, P. and Verma, S. (2022). Influence of row spacing on dry matter production in proso millet. *Journal of Agricultural Research,* **15**(3), 45-52.

PIB (2023). Press Information Bureau. Delhi. Area production and productivity of small millet in India and Bihar. Available at: Press Information Bureau (pib.gov.in)

Ramadevi, S., Sagar, G. K., Subramanyam, D. and Kumar, A.R. (2021). Weed management in transplanted finger millet with pre-and post-emergence herbicides. *Indian Journal of Weed Science,* **53**(3), 297–299.

Rao, A.S., Prithvi, B.K. and Srinivasulu, K. (2015). Weed management in transplanted ragi. *Indian Journal of Weed Science,* **47**(2), 214–215.

Singh, B., Patel, R. and Kumar, S. (2016). Weed management practices in finger millet *(Eleusine coracana*) and their impact on crop growth and yield. *Indian Journal of Weed Science,* **48**(2), 122–126.

Singh, P., Kumar, S. and Sharma, V. 2016. Response of finger millet (*Eleusine coracana*) to varying row spacing and fertility levels. *Indian Journal of Agricultural Sciences,* **86**(8), 985-990.

Singh, P., Singh, R. and Kumar, P. 2015. Effect of plant density on growth and yield of pearl millet (*Pennisetum glaucum* L.). *Journal of Agricultural Science and Technology,* **15**(3), 538-547.

Upadhaya, B., Kishor, K. and Kumar, R. (2022). Foxtail millet (*Setaria italica*) growth, yield and economics as affected by liquid biofertilizers and their mode of application. *The Pharma Innovation Journal,* 11(2): 2225-2230.

Upadhaya, B., Tiwari, R. K., Kishor, K., Harsha, B. R., Singh, S. K., Kumar, S. and Kumar, S. (2024). Herbicide evaluation in direct seeded rice in the middle Gangetic plains of India. *Weed Biology and Management,* 1–9.