

Performance of sunhemp to irrigation and foliar nutrition in rice fallows

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ABSTRACT

A field experiment entitled “Response of sunhemp to irrigation and foliar nutrition in rice fallows” was conducted during *rabi*, 2024-25 at the College Farm, Agricultural College, Naira. The experiment was laid out in Split-plot design, replicated thrice with four main plots *viz.*, I₁- One Irrigation at 45 DAS; I₂-Two Irrigations at 45 and 75 DAS; I₃-Three irrigations at 45, 60 and 75 DAS and I₄- No irrigation and Five Sub Plots *viz.*, F₁- Nano Urea @ 4 ml/lit at flower initiation and pod development stages; F₂- Nano DAP @ 2.5 ml/lit at flower initiation and pod development stages; F₃- 19:19:19 (NPK) @ 10 gm/l at flower initiation and pod development stages; F₄- KNO₃ @ 10 gm/l at flower initiation and pod development stages; F₅- water spray. The results revealed that three irrigations at 45, 60 and 75 DAS (I₃) was recorded higher values of plant height (131.6 cm), branches plant⁻¹ (8.4), dry matter production (4971 kg ha⁻¹) at harvest, number of pods plant⁻¹ (22.6), number of seeds pod⁻¹ (8.9) and seed yield (957 kg ha⁻¹). Among foliar applications, the application of KNO₃ @ 10 gm/l (F₄) at flower initiation and pod development stages recorded significantly higher values of plant height (125.3 cm), branches plant⁻¹ (8.0), dry matter production (4373 kg ha⁻¹) at harvest, number of pods plant⁻¹ (23.0), number of seeds pod⁻¹ (8.8) and seed yield (866 kg ha⁻¹).

Keywords: *Foliar nutrition, KNO₃, Nano Urea, Rice fallows and Sunhemp*

Sunhemp (*Crotalaria juncea* L.) is an ancient fiber crop known as Bombay hemp and most popular green manure crop native to India. Sunhemp is widely cultivated due to its dual use as a green manure and for seed purpose. It's significance found in soil conservation, organic matter improvement and nutrient recycling, particularly in degraded soils with falling fertility (Ram *et al.* 2022). India is the world's largest producer of sunhemp predominantly grown in Uttar Pradesh, Madhya Pradesh, Odisha, Andhra Pradesh, Rajasthan, Bihar, Maharashtra, Karnataka, Gujarat, West Bengal, Assam, Tamil Nadu, Punjab and Haryana. Area under sunhemp in Andhra Pradesh for seed and fibre is 7132 ha. Sunhemp was identified as ideal crop for seed production during *rabi* in rice fallow situation. Studies show that two or three irrigations during critical crop growth periods can significantly enhance biomass production, seed setting and fiber quality, particularly under rainfed rice fallow

conditions. Traditionally, rice fallow sunhemp relied solely on residual soil nutrients with no nutrient supplementation and basal fertilization. Foliar nutrition is now recognized as an efficient method to supply essential nutrients quickly during key growth stages, especially in rice fallow conditions where root activity is limited by soil dryness. Keeping these points in view, the present investigation was undertaken with the objective to study “Response of sunhemp to irrigation and foliar nutrition in rice fallows” was conducted during *Rabi*, 2024-25.

MATERIAL AND METHODS

The present field experiment was conducted during *rabi*, 2024-25 at Block- C of the College Farm, Agricultural College, Naira, Acharya N.G. Ranga Agricultural University,

Andhra Pradesh. The experiment was laid out in Split-plot design, replicated thrice with Four Main

Plots viz., One Irrigation at 45 DAS (I_1); Two Irrigations at 45 and 75 DAS (I_2); Three irrigations at 45, 60 and 75 DAS (I_3) and No irrigation (I_4) and Five Sub Plots viz., Nano Urea @ 4 ml/lit (F_1) at flower initiation and pod development stages; Nano DAP @ 2.5 ml/lit (F_2) at flower initiation and pod development stages; 19:19:19 (NPK) @ 10 gm/l (F_3) at flower initiation and pod development stages; KNO_3 @ 10 gm/l (F_4) at flower initiation and pod development stages; water spray (F_5). Crop was planted through broadcasting in prior to rice harvest. The crop was grown on residual moisture up to first irrigation and there after irrigation scheduling was done based on the treatment requirement individually in the respective plots. Foliar sprays were given at flower initiation and pod development stages as per the treatment. Observations were recorded on five randomly selected plants from each plot. The readings from these five plants were averaged replication-wise and the mean data were used for statistical analysis. Data on various variables were analysed by analysis of variance (Panse and Sukhatme, 1985) and OPSTAT software programme.

RESULTS AND DISCUSSION

3.1. Influence of number of irrigations and foliar nutrition on growth parameters of sunhemp

Among all growth parameters the plant height, number of branches plant⁻¹ and dry matter production (kg ha⁻¹) are significantly influenced by number of irrigations at harvest. The higher values of plant height (131.6 cm) at harvest was recorded with three irrigations at 45, 60 and 75 DAS (I_3) and superior over two irrigations at 45 and 75 DAS (I_2), one irrigation at 45 DAS (I_1) and no irrigation (I_4) and the lower was recorded with no irrigation (I_4) with (95.6 cm). These findings align with those of Sharma *et al.* (2019), who reported increased plant height under frequent irrigation schedules in legume crops. In case of foliar nutrition, all growth parameters were significantly influenced at harvest. The foliar application of KNO_3 @ 10 gm/l (F_4) sprayed at flower initiation and pod development stages has recorded the higher values of plant height (125.3 cm) followed by Nano Urea @ 4 ml/lit (F_1) i.e., 121.7 cm and 19:19:19 (NPK) @ 10 gm/l (F_3) i.e., 120.1 cm. The superior performance of KNO_3 may be due to its role in regulating osmotic balance, enhancing enzyme activity and promoting vegetative growth.

Similar positive responses of foliar-applied potassium on plant growth have been reported by Gowda *et al.* (2021).

Maximum number of branches plant⁻¹ (8.4) was observed in three irrigations at 45, 60 and 75 DAS (I_3) and minimum number of branches plant⁻¹ was recorded with no irrigation (I_4). These findings are supported by the reports of Chandrashekar and Bangarusamy, (2003) who observed better branching in legumes with increased irrigation frequency. Among foliar nutrition, the maximum number of branches plant⁻¹ (8.0) were recorded at harvest with foliar spray of KNO_3 @ 10 gm/l (F_4) which was on par with Nano Urea @ 4 ml/lit (F_1) and 19:19:19 (NPK) @ 10 gm/l (F_3). The increased branching in KNO_3 @ 10 gm/l (F_4) may be due to potassium's critical role in enzyme activation, protein synthesis and assimilate translocation which directly influence branching and growth. Similar observations were reported by Kumbhar *et al.* (2015) and Darade *et al.* (2019).

Dry matter production showed a progressive increase with the number of irrigations. The higher dry matter production was observed at three irrigations at 45, 60 and 75 DAS (I_3), and it was superior over two irrigations at 45 and 75 DAS (I_2), one irrigation at 45 DAS (I_1) and no irrigation (I_4). The lower values of dry matter was recorded under no irrigation (I_4). The enhancement in dry matter with increased irrigation frequency may be attributed to sustained moisture availability by facilitating higher metabolic and physiological activity, resulting in plants with more branches, there by improved biomass accumulation.

With regard to foliar nutrition, the highest dry matter production at harvest was observed in KNO_3 @ 10 g/l (F_4) sprayed at flower initiation and pod development stages which was superior over nano urea @ 4 ml/l (F_1) and 19:19:19 @ 10 g/l (F_3), nano DAP @ 2.5 ml/l (F_2) and water spray (F_5). While the lower values of dry matter was recorded in water spray (F_5). These findings are consistent with the work of Gulati *et al.* (2020), who demonstrated the enhanced dry matter accumulation in pulses with foliar application of KNO_3 .

Influence of number of irrigations and foliar nutrition on yield contributing parameters of sunhemp.

Yield attributes of sunhemp are crucial and highly valued characteristics as they have a direct

Table.1. Influence of number of irrigations and foliar nutrition on growth parameters at harvest and yield attributing characters of sunhemp in rice fallows

Treatments	Growth attributes			Yield attributes		
	Plant height (cm)	No. of branches Plant-1	Dry matter Production (kg ha-1)	No. of pods plant-1	No. of seeds pod-1	Test weight (g)
Irrigation						
I ₁ : One irrigation at 45 DAS	112.7	7.4	3375	20.1	8.0	39.6
I ₂ : Two irrigations at 45 and 75 DAS	125.3	7.9	4430	21.4	8.2	40.9
I ₃ : Three irrigations at 45, 60 and 75 DAS	131.6	8.4	4971	22.6	8.9	42.6
I ₄ : Control	95.6	5.8	1527	13.9	6.2	31.7
SEm ⁺	2.9	0.1	103.8	0.5	0.1	1.0
CD (p=0.05)	10.1	0.5	359.2	1.6	0.5	3.6
CV (%)	9.7	8.4	11.2	9.4	7.3	10.4
Foliar nutrition						
F ₁ : Foliar application of Nano Urea @ 4 ml/l water twice at flower initiation and pod development stages	121.7	7.9	3847	21.8	8.4	41.7
F ₂ : Foliar application of Nano DAP @ 2.5 ml/l water twice at flower initiation and pod development stages	116.7	7.5	3059	18.6	7.9	38.2
F ₃ : Foliar application of 19:19:19 @ 10 g /l water twice at flower initiation and pod development stages	120.1	7.6	3651	20.6	8.0	40.7
F ₄ : Foliar application of KNO ₃ @ 10 g/l water at flower initiation and pod development stages	125.3	8.0	4373	23	8.8	42.6
F ₅ : Control (Water spray)	97.7	5.9	2950	13.4	6.0	30.4
SEm ⁺	2.6	0.3	111.5	0.5	0.2	0.9
CD (p=0.05)	7.4	0.6	321.1	1.5	0.5	2.6
CV (%)	7.7	10.0	10.7	9.7	7.8	8.1

impact on its overall productivity. The data presented in table.1 indicated that number of pods plant⁻¹, seeds pod⁻¹ and test weight (g) showed significant impact by increased number of irrigations. The highest no. of pods plant⁻¹, no. of seeds pod⁻¹ and test weight were recorded with three irrigations at 45, 60 and 75 DAS (I₃) and least was with no irrigation (I₄). In contrast, the control treatment which did not receive any irrigation experienced moisture stress that may have hindered flower development and led to reduced pod set.

Among foliar nutrition, the highest number no. of pods plant⁻¹, no. of seeds pod⁻¹ and test weight were recorded with foliar spray of KNO₃ @ 10 gm/l (F₄) which was on par with Nano Urea @ 4 ml/lit (F₁) and the lower values of yield attributes were recorded under water spray (F₅). The superior performance of KNO₃ and nano urea treatments can be attributed to their effectiveness in meeting crop nutrient demands during critical stages through quick absorption and translocation especially under variable soil nutrient conditions. Potassium is known to

enhance photosynthate transport and flower-to-pod conversion while foliar-applied nitrogen supports cell division and reproductive organ development. These findings are in accordance with the reports of Patra *et al.* (2021) and Bora *et al.* (2021).

Influence of number of irrigations and foliar nutrition on yield of sunhemp.

The seed yield was significantly influenced by both number of irrigations and foliar nutrition. The higher seed yield was recorded under three irrigations at 45, 60 and 75 DAS (I₃) which was 15%, 38% and 109 % higher than two irrigations (I₂), one irrigation (I₁) and no irrigation (I₄) respectively. These results align with Meena *et al.* (2021), who highlighted the importance of irrigation during reproductive stages in legumes. Among foliar treatments, KNO₃ @ 10 g/l (F₄) produced the higher values of seed yield which was statistically on par with nano urea @ 4 ml/l (F₁) and significantly superior to 19:19:19 (F₃), nano DAP (F₂) and water spray (F₅). Yield under F₄ was 3% higher than nano urea, 16 % over 19:19:19, 20 %

Table.2. Yield and economics of sunhemp influenced by number of irrigations and foliar nutrition

Treatments	Yield		Economics		
	Seed Yield (kg ha-1)	Haulm Yield (kg ha-1)	Gross returns (Rs. ha-1)	Net returns (Rs. ha-1)	B:C ratio
Irrigation					
I ₁ : One irrigation at 45 DAS	692	2448	73354	37220	2
I ₂ : Two irrigations at 45 and 75 DAS	832	3451	88163	51329	2.39
I ₃ : Three irrigations at 45, 60 and 75 DAS	957	3603	101569	64023	2.7
I ₄ : Control	456	1024	48298	12648	1.35
SEm _±	19.2	77.4	1487.39	653.42	0.03
CD (p=0.05)	66.4	268	5147.23	2261.2	0.11
CV (%)	10.1	11.4	7.4	6.1	6
Foliar nutrition					
F ₁ : Foliar application of Nano Urea @ 4 ml/l water twice at flower initiation and pod development stages	842	2974	89287	53237	2.46
F ₂ : Foliar application of Nano DAP @ 2.5 ml/l water twice at flower initiation and pod development stages	721	2443	76377	39353	2.05
F ₃ : Foliar application of 19:19:19 @ 10 g /l water twice at flower initiation and pod development stages	748	2895	79234	41801	2.11
F ₄ : Foliar application of KNO ₃ @ 10 g/l water at flower initiation and pod development stages	866	3493	91873	54590	2.47
F ₅ : Control (Water spray)	495	1353	52457	17543	1.5
SEm _±	22.3	68.4	1957.08	1260.37	0.06
CD (p=0.05)	64.2	197.1	5637.88	3630.82	0.18
CV (%)	10.5	9	8.8	10.6	10

over nano DAP and up to 75% higher than water spray. Improved yields with KNO₃ and nano urea are likely due to efficient nutrient uptake and enhanced physiological functions during flowering and pod development, consistent with the findings of Kumawat *et al.* (2022).

Haulm yield of sunhemp was significantly influenced by both irrigation and foliar nutrition (Table 2). The highest haulm yield was recorded with three irrigations at 45, 60 and 75 DAS (I₃) which was statistically comparable with two irrigations at 45 and 75 DAS (I₂) while the lowest yield was observed under no irrigation (I₄). These results are supported by Sahu *et al.* (2022), who reported enhanced shoot biomass with consistent irrigation.

Among foliar treatments, KNO₃ @ 10 g/l (F₄) produced the maximum haulm yield were significantly outperforming over nano urea (F₁),

19:19:19 (F₃), nano DAP (F₂) and water spray (F₅). The superior performance of F₄, may be attributed to the role of potassium in regulating stomatal function and translocating assimilates, along with nitrogen's contribution to vegetative growth. Foliar feeding at flowering and pod development stages ensured timely nutrient availability, leading to improved plant vigour and biomass, as also noted by Patel *et al.* (2021).

ECONOMICS

Economic evaluation revealed that three irrigations at 45, 60, and 75 DAS (I_f) gave the highest gross and net returns with a B:C ratio of 2.70, outperforming the control (I₄), which recorded the lowest returns and a B:C ratio of 1.35. The economic gain of I₃ over I₄ was ¹ 53,271 of gross and ¹ 51,375 of net returns. Among foliar treatments, KNO₃ @ 10 g/l (F₄) recorded the highest gross and net returns

with a B:C ratio of 2.47 significantly superior to the control (F_5). The improvement with F_4 over F_5 was $^{1}39,416$ of gross and $^{1}37,047$ of net returns indicating better profitability with timely irrigation and effective foliar nutrition. Enhanced profitability under KNO_3 and nano urea could be attributed to improved crop growth and yield efficiency. Similar observations were made by Martin Stanley (2013) and Kumar & Simaiya (2019).

CONCLUSION

Based on the experimental findings it could be concluded that rice fallow sunhemp requires three irrigations at 45, 60 and 75 DAS coupled with foliar spray of KNO_3 @ 10 g/l or nano urea @ 4 ml/l at flower initiation and pod development stages to reap maximum seed yield and higher net returns.

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