

Research Paper



Influence of zinc sulphate and potassium nitrate on morpho-physiological parameters, yield and yield attributes of lathyrus

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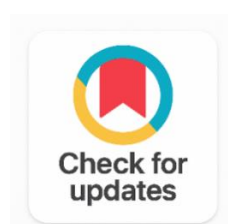
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ABSTRACT

A field experiment was conducted during rabi 2021-22, to study the influence of zinc sulphate and potassium nitrate on morpho-physiological parameters, yield and yield contributes of lathyrus cv. Ratan. The experiment was laid down in randomized block design with nine treatments and three replications at research farm of Botany Section College of Agriculture, Nagpur. The aim of this work was to study the effect of foliar application of zinc sulphate at 0.25, 0.50, 0.75 and 1% and potassium nitrate at 0.20, 0.40, 0.60 and 0.80% on biochemical parameters and yield in lathyrus. Spraying of zinc sulphate and potassium nitrate was done two times i.e. on 20 and 40 DAS. Observations about morpho-physiological parameters like plant height, number of branches, total dry matter production and leaf area were also estimated. Observation on yield contributing parameters like 100 seed weight (g), number of pods plant⁻¹, grain yield plant⁻¹, plot⁻¹, ha⁻¹, harvest index recorded. Foliar sprays of 0.80% KNO₃ followed by 0.60% KNO₃ significantly enhanced biochemical parameters and yield contributing parameters when compared with control and rest of the treatments under study.

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1. INTRODUCTION

Lathyrus sativus, also known as grass pea, cicerchia, blue sweet pea, chickling pea, chickling vetch, Indian pea, white pea and white vetch, is a legume (family Fabaceae) commonly grown for human consumption and livestock feed in Asia and East Africa. It is a particularly important crop in areas that are prone to drought and famine, and is thought of as an 'insurance crop' as it produces reliable yields when all other crops fail.

The edible *Lathyrus sativus* originated in the West Central Asia Mediterranean region and North India was its centre of domestication. The states which cultivate lathyrus are Maharashtra, Madhya Pradesh, Bihar, West Bengal and Eastern Uttar Pradesh contributing about 4.5% total pulse production of the country. In Maharashtra it is cultivated in Bhandara, Chandrapur, Gadchiroli, Gondia and Nagpur districts of eastern Vidarbha.

Zinc sulphate is the inorganic compound with equation $ZnSO_4$. It was generally known as "white vitriol". It is a powder that is colourless and totally water solvent. It is a fundamental part of catalysts engaged with metabolic reaction. Zinc sulphate is most ordinarily utilized source of zinc in granular fertilizer due to its high solvency in water and it is relatively low cost of production. They are responsible for use in a wide range of soils. It influences a few biochemical cycles in the plant, like cytochrome and nucleotide synthesis, chlorophyll production, enzyme activation, membrane integrity and hormone regulation (e.g., Tryptophan synthesis, a precursor of IAA). Sulphur assumes urgent part in controlling metabolic and enzymatic cycles including photosynthesis, respiration and legume rhizobium symbiotic nitrogen fixation, energy transformation, activation of enzymes and also in carbohydrate metabolism which reflected in expanded yield [1].

Potassium is known to be taken up by plant roots at high rates and is quickly transported to the upper plant parts. The downward transport of K from tops to roots is also a rapid process, so that once K is absorbed, it is readily distributed throughout the entire plant. K is taken up from the soil solution by root epidermal and cortical cells. Once K is inside the root symplast, it may be sorted in vacuoles, where it fulfills osmotic functions, or is transported to the shoot via xylem [2].

2. METHODOLOGY

The project entitled "influence of zinc sulphate and potassium nitrate on morpho-physiological parameters, yield and yield contributes of lathyrus" was conducted during rabi season 2021-22 at research farm of Botany Section College of Agriculture, Nagpur in a Randomized Block Design with nine treatments and three replications. Treatment consists of T1 (control), T2 ($ZnSO_4$ 0.25%), T3 ($ZnSO_4$ 0.50%), T4 ($ZnSO_4$ 0.75%), T5 ($ZnSO_4$ 1.0%), T6 (KNO_3 0.20%), T7 (KNO_3 0.40%), T8 (KNO_3 0.60%) and T9 (KNO_3 0.80%) were tested. The gross plot size was 2.70 m x 2.20 m and net plot size was 2.10 m x 2.00 m with spacing of 30 cm x 10 cm. Five plants from each plot were selected randomly and data were collected at 25, 45 and 65 DAS on plant height, number of branches, total dry matter production and leaf area were calculated. Test weight, number pods, grain yield plant⁻¹, plot⁻¹, ha⁻¹, harvest index were calculated after harvest. Data was estimated by to statistical analysis as per method suggested by Panse and Sukhatme [3].

3. RESULTS AND DISCUSSION

3.1 Plant Height

The data regarding the plant height at 25 DAS were found statistically significant. At 25 DAS the range of plant height was recorded 7.08 – 9.54 cm. significantly maximum plant height was registered in treatment T₉ (KNO_3 0.80%) followed by treatments T₈ (KNO_3 0.60%), T₅ ($ZnSO_4$ 1.0%), T₄ ($ZnSO_4$ 0.75%), T₇ (KNO_3 0.40%) and T₆ (KNO_3 0.20%) over control and rest of the treatments. Whereas the treatments T₃ ($ZnSO_4$ 0.50%) and T₂ ($ZnSO_4$ 0.25%) in descending order also found significantly superior over treatments over T₁ control.

At 45 DAS the range of plant height was recorded 17.06 – 25.22 cm. At this stage significantly highest plant height was noticed in plant expose to the treatment T₉ (KNO₃ 0.80%) followed by treatments T₈ (KNO₃ 0.60%), T₅ (ZnSO₄ 1.0%), T₄ (ZnSO₄ 0.75%), T₇ (KNO₃ 0.40%) and T₆ (KNO₃ 0.20%) over control (T₁). Next to these treatments significantly more plant height was also recorded in treatments T₃ (ZnSO₄ 0.50%) and T₂ (ZnSO₄ 0.25%) were found at par with control.

At 65 DAS the range of plant height was observed 34.11 - 52.69 cm. The significantly superior plant height was registered in treatment T₉ (KNO₃ 0.80%) followed by treatments T₈ (KNO₃ 0.60%), T₅ (ZnSO₄ 1.0%), T₄ (ZnSO₄ 0.75%), T₇ (KNO₃ 0.40%) and T₆ (KNO₃ 0.20%), over control and rest of the treatments. Whereas the treatments T₃ (ZnSO₄ 0.50%) and T₂ (ZnSO₄ 0.25%) were found significant over treatment T₁ control.

Similar result were observed by [4] examined the effect of zinc as a foliar application on chickpea and recorded significant increase in plant height by the application of 0.5% ZnSO₄. [5] Observed that influence of ferrous sulphate and zinc sulphate on morpho-physiological parameters and yield in chickpea and recorded maximum height in 0.5 % ZnSO₄. Almost similar result were reported by [6], [7] that effect of potassium level on performance of chickpea and recorded maximum height in level 90 kg potassium ha⁻¹. Whereas, [8] observed that the foliar application of KNO₃ @ 2% showed maximum plant height.

3.2 Number of Branch

At 25 DAS data recorded about number of branches plant⁻¹ was statistically significant. At 25DAS range of number of branches plant⁻¹ recorded was 3.35 – 4.62. Significantly highest number of branches plant⁻¹ was recorded in treatment T₉ (KNO₃ 0.80%) followed by treatments T₈ (KNO₃ 0.60%), T₅ (ZnSO₄ 1.0%), T₄ (ZnSO₄ 0.75%) and T₇ (KNO₃ 0.40%) and over control and rest of the treatments. Whereas the treatments T₆ (KNO₃ 0.20%), T₃ (ZnSO₄ 0.50%) and T₂ (ZnSO₄ 0.25%) were found at par with control.

At 45 DAS range of number of branches plant⁻¹ recorded was 5.23 – 7.28. At 45 DAS significantly highest number of branches plant⁻¹ was observed in treatment T₉ (KNO₃ 0.80%) followed by treatments T₈ (KNO₃ 0.60%), T₅ (ZnSO₄ 1.0%) and T₄ (ZnSO₄ 0.75%) as compared with control (T₁). Next to these treatments significantly more plant height was also recorded in treatments T₇ (KNO₃ 0.40%), T₆ (KNO₃ 0.20%) T₃ (ZnSO₄ 0.50%) and T₂ (ZnSO₄ 0.25%) were found at par with control.

At 65 DAS range of number of branches plant⁻¹ recorded was 6.05 – 9.02. At 65 DAS significantly maximum number of branches plant⁻¹ was registered in treatment T₉ (RDF + KNO₃ 0.80%) followed by treatments T₈ (KNO₃ 0.60%), T₅ (ZnSO₄ 1.0%), T₄ (ZnSO₄ 0.75%), T₇ (KNO₃ 0.40%), T₆ (KNO₃ 0.20%) and T₃ (ZnSO₄ 0.50%) over control and rest of the treatments. But, treatment T₂ (ZnSO₄ 0.25%) were found at par with control.

The marked superiority in growth parameters like branches observed due to potassium which enhances plant vigour and strengthens the stalk.

[8] Investigate the response of different potassium application rates on growth, yield, carbohydrates and protein content of mungbean. K₄ (0.5g /pot) significantly enhanced the number of branches plant⁻¹ in mungbean. Whereas [9] revealed that the foliar spray of KNO₃ (2%) enhanced the number of branches plant⁻¹ in lentil. Almost similar result were reported by [6], [7] that effect of potassium level on performance of chickpea and recorded maximum number of branches plant⁻¹ in level 90 kg potassium ha⁻¹. However, [5] observed that influence of ferrous sulphate and zinc sulphate on morpho-physiological parameters and yield in chickpea and recorded maximum number of branches plant⁻¹ in 0.5 % ZnSO₄.

3.3 Total Dry Matter Production

Scrutiny of the data revealed marked effect of foliar spray of ZnSO₄ and KNO₃ on the total dry matter production of lathyrus at 25, 45 and 65 DAS.

The data recorded about the total dry matter production were found statistically significant at 25 DAS. The range of dry matter production recorded was 0.44 – 0.75 g. significantly maximum dry matter production was noticed in treatment T₉ (KNO₃ 0.80%) followed by treatments T₈ (KNO₃ 0.60%), T₅ (ZnSO₄ 1.0%), T₄ (ZnSO₄ 0.75%) T₇ (KNO₃ 0.40%) and T₆ (KNO₃ 0.20%) when compared with treatment T₁

(control). Next to these treatments significantly more dry matter production was also recorded in treatments T₃ (ZnSO₄ 0.50%) and T₂ (ZnSO₄ 0.25%) were found at par with control.

At 45 DAS the range of total dry matter production recorded was 1.35 – 1.78 g. Significantly maximum dry matter production was registered in treatment T₉ (KNO₃ 0.80%) followed by treatments T₈ (KNO₃ 0.60%), T₅ (ZnSO₄ 1.0%), T₄ (ZnSO₄ 0.75%) T₇ (KNO₃ 0.40%) and T₆ (KNO₃ 0.20%), over control and rest of the treatments. Next to these treatments significantly more dry matter production was also recorded in treatments T₃ (ZnSO₄ 0.50%) and T₂ (ZnSO₄ 0.25%) were found at par with control.

At 65 DAS the range of total dry matter production recorded was 4.45 - 6.66 g. significantly maximum dry matter production was registered in treatment T₉ (KNO₃ 0.80%) followed by treatments T₈ (KNO₃ 0.60%), T₅ (ZnSO₄ 1.0%), T₄ (ZnSO₄ 0.75%) T₇ (KNO₃ 0.40%), T₆ (KNO₃ 0.20%) and T₃ (ZnSO₄ 0.50%) over control. Next to these treatments significantly more dry matter production was also noticed in treatments and T₂ (ZnSO₄ 0.25%) were found at par with control.

Similar result recorded by [9] who revealed that the foliar spray of KNO₃ (2%) enhanced the dry matter production in lentil. Whereas [10] who reported that application of foliar application of ZnSO₄ 0.5% was found more effective in increasing the total dry matter production, when compared with control in lathyrus. Also [5] observed that influence of ferrous sulphate and zinc sulphate on morpho-physiological parameters and yield in chickpea and recorded maximum total dry matter production in 0.5 % ZnSO₄. Almost similar result were reported by [6], [7] that effect of potassium level on performance of chickpea and recorded increased total dry matter production in level 90 kg potassium ha⁻¹.

3.4 Leaf Area Plant⁻¹

Data pertaining to leaf area plant⁻¹ at 25, 45 and 65 DAS as influenced by different treatments was tabulated in Table 1. Leaf area plant⁻¹ gradually increased from 20 DAS and reached maximum value at 60 DAS in all the treatments.

Observations recorded at 25 DAS indicated significant variation. At 25 DAS the range of leaf area plant⁻¹ recorded was 0.55 – 0.81 dm². The most pronounced effect observed in plant expose to the treatment T₉ (KNO₃ 0.80%) followed by treatments T₈ (KNO₃ 0.60%), T₅ (ZnSO₄ 1.0%), T₄ (ZnSO₄ 0.75%), T₇ (KNO₃ 0.40%) and T₆ (KNO₃ 0.20%), in leaf area over control and rest of the treatments under study. Next to these treatments significantly more Leaf area was also recorded in treatments T₃ (ZnSO₄ 0.50%) and T₂ (ZnSO₄ 0.25%) were found at par with control.

At 45 DAS the range leaf area plant⁻¹ recorded was 1.39 – 1.80 dm². The significantly highest leaf area over control was observed at 45 DAS in treatment T₉ (KNO₃ 0.80%) followed by treatments T₈ (KNO₃ 0.60%), T₅ (ZnSO₄ 1.0%), T₄ (ZnSO₄ 0.75%), T₇ (KNO₃ 0.40%) and T₆ (KNO₃ 0.20%) in a descending manner. But treatments T₃ (ZnSO₄ 0.50%) and T₂ (ZnSO₄ 0.25%) were found at par with control.

At 65 DAS the range of leaf area plant⁻¹ recorded was 3.22 – 4.57 dm². At 65 DAS significantly highest leaf area was registered in treatment T₉ (KNO₃ 0.80%) followed by treatments T₈ (KNO₃ 0.60%), T₅ (ZnSO₄ 1.0%), T₄ (ZnSO₄ 0.75%), T₇ (KNO₃ 0.40%) and T₆ (KNO₃ 0.20%) over control and rest of the treatments under study. Next to these treatments significantly more Leaf area was also recorded in a treatment T₃ (ZnSO₄ 0.50%) and T₂ (ZnSO₄ 0.25%) were found at par with control.

Similar results were reported by [11] studied the effect of Zinc and Iron fortification on growth, pod yield, zinc uptake of groundnut genotypes. The application of 0.5% ZnSO₄ significantly leaf area at harvest. Whereas [12], who reported that application of RDF + foliar application of ZnSO₄ 0.5% was found more effective in enhancing leaf area, when compared with control in lathyrus. Our results are in line with that of [4], who observed that foliar application of 0.5% zinc significantly enhanced leaf area over control in chickpea. Also [5] observed that influence of ferrous sulphate and zinc sulphate on morpho-physiological parameters and yield in chickpea and recorded maximum leaf area plant⁻¹ in 0.5 % ZnSO₄.

3.5 Test Weight

The range of test weight recorded after harvest was 2.70-3.86 g. significantly highest test weight content was found in T₉ KNO₃ @ 0.80% (3.86 g).

Application of zinc sulphate and potassium nitrate as foliar spray increased the seed weight due

to movement of nutrients in plants for redistribution of minerals to the grains, extend the grain filling period leading to improvement in grain weight.

According to results of [12], who studied the influence of zinc and iron on morpho-physiological parameters and yield of lathyrus (*Lathyrussativus* L.) and stated that application of ZnSO_4 0.5% foliar spray at 25 and 40 DAS recorded highest test weight over control. However, [13] observed that the foliar application of 0.5% KNO_3 showed highest test weight in wheat. Almost similar result were reported by [6], [7] that effect of potassium level on performance of chickpea and recorded maximum weight of 100 seeds in level 90 kg potassium ha^{-1} . Whereas, [8] observed that the foliar application of 2% KNO_3 showed that the significantly highest number of grain plant⁻¹ and weight of 1000 seeds in wheat.

3.6 Number of Pod Plant⁻¹

At harvest the range of number of pod plant⁻¹ was observed in the range of 60.15-78.33. Significantly highest number of pod was found in $\text{T}_9 \text{KNO}_3$ @ 0.80% (78.33) followed by $\text{T}_8 \text{KNO}_3$ @ 0.60% (75.67) and $\text{T}_7 \text{ZnSO}_4$ @ 1% (75). The significant increase in number of pods was observed due to spraying of zinc sulphate and potassium nitrate at 25, 45 and 65 DAS.

Results regarding number of pods plant⁻¹ by [14] found that combined spraying of 0.5% ZnSO_4 at 45 DAS recorded significantly higher pods plant⁻¹ in cowpea. However, [15] recorded foliar spray of 0.5% Zn produced maximum number of pods plant⁻¹ in chickpea. According to results of [12], who studied the influence of zinc and iron on morpho-physiological parameters and yield of lathyrus (*Lathyrus sativus* L.) and stated that application of ZnSO_4 0.5% foliar spray at 25 and 40 DAS recorded highest number of pods plant⁻¹ over control. Almost similar result were reported by [6], [7] that effect of potassium level on performance of chickpea and recorded maximum weight of 100 seeds and number of pods plant⁻¹ in level 90 kg potassium ha^{-1} . However, [7] observed that the foliar application of 2% KNO_3 showed that the significantly highest number of grain plant⁻¹ and weight of 1000 seeds in wheat.

3.7 Seed Yield Plant⁻¹(G), Plot⁻¹ (Kg) and Ha⁻¹(Q)

Significantly maximum seed yield plant⁻¹, plot⁻¹ and hectare⁻¹ were produced in treatment $\text{T}_9 \text{KNO}_3$ @ 0.80% followed by $\text{T}_8 \text{KNO}_3$ @ 0.60%, $\text{T}_7 \text{ZnSO}_4$ @ 1%, T_6 (KNO_3 0.20%), T_3 (ZnSO_4 0.50%) and T_2 (ZnSO_4 0.25%) over control.

The range of increase in seed yield plant⁻¹, plot⁻¹ and hectare⁻¹ was 2.82 g, 0.44 kg and 10.55 q in treatment T_1 (control) and 4.28 g, 0.68 kg and 16.26 q in treatment $\text{T}_9 \text{KNO}_3$ @ 0.80% respectively. The above finding was in corroboration with the findings of [16] observed foliar spray of KNO_3 and ZnSO_4 on yield ascribing characters of grass pea. Foliar spray of KNO_3 at 0.50% during 50% flowering stage showed maximum values of length of pod, seeds pod⁻¹ and 1000 seed weight; it was essentially better than water spray and unsprayed control. Whereas, [14] recorded that the foliar application of micronutrients like iron and zinc had significant Influence on the yield of cowpea. 0.5% ZnSO_4 , at 45 DAS proved most effective and increased the seed yield by 43.09% when compared with control followed by combined spraying of 0.5% ZnSO_4 , at 25 DAS (40.14%). The net return and benefit:cost ratio also followed the same [17].

3.8 Morphophysiological Analysis

Table 1. Plant Height, Number of Branches Plant⁻¹, Leaf Area Plant⁻¹, Total Dry Weight of Plant (G)

Treatments	Plant Height Plant ⁻¹			Number of Branches Plant ⁻¹			Leaf Area Plant ⁻¹			Total Dry Weight of Plant (G)		
	25 DAS	45 DAS	65 DAS	25 DAS	45 DAS	65 DAS	25 DAS	45 DAS	65 DAS	25 DAS	45 DAS	65 DAS
T1 CONTROL	7.0 8	17.0 6	34.1 1	3.3 5	5.2 3	6.0 5	0.5 5	1.3 9	3.2 2	0.4 4	1.3 5	4.4 5
T2 ZnSO_4 @0.25 %	8.8 2	22.6 6	47.8 4	3.7 6	5.6 5	7.2 2	0.6 2	1.5 3	3.7 7	0.4 7	1.5 0	4.9 3
T3	8.7	22.9	47.9	3.7	5.7	7.7	0.6	1.5	3.8	0.5	1.5	5.6

ZnSO ₄ @0.50 %	8	7	0	9	4	1	5	9	2	2	3	7
T4 ZnSO ₄ @0.75 %	9.0 5	23.7 5	48.5 7	4.2 0	6.4 5	8.5 3	0.7 2	1.7 1	4.3 3	0.6 9	1.6 6	6.3 3
T5 ZnSO ₄ @1%	9.1 7	24.4 0	48.9 0	4.3 6	6.8 2	8.6 5	0.7 6	1.7 6	4.4 0	0.7 2	1.7 0	6.4 5
T6 KNO ₃ @0.20%	8.8 3	23.4 3	48.0 4	3.8 3	5.8 0	8.1 2	0.6 7	1.6 1	3.8 8	0.5 9	1.5 7	5.7 8
T7 KNO ₃ @0.40%	8.9 5	23.9 8	48.3 4	4.1 6	6.0 1	8.2 7	0.7 0	1.6 9	3.9 2	0.6 5	1.6 1	6.1 3
T8 KNO ₃ @0.60%	9.3 2	24.8 2	50.0 0	4.5 3	7.1 8	8.8 7	0.7 9	1.7 8	4.4 9	0.7 3	1.7 3	6.5 9
T9 KNO ₃ @0.80%	9.5 4	25.2 2	52.6 9	4.6 2	7.2 8	9.0 2	0.8 1	1.8 0	4.5 7	0.7 5	1.7 8	6.6 6
SE(m)	0.3 5	1.22	2.63	0.2 0	0.3 6	0.4 7	0.3 6	0.0 6	0.2 1	0.0 4	0.0 6	0.3 7
CD	1.0 7	3.66	7.90	0.6 2	1.1 0	1.4 2	0.1 0	0.2 0	0.6 3	0.1 2	0.1 9	1.1 2

Table 2. Test Weight, Number of Pod Plant⁻¹, Seed Yield Plant⁻¹ (G), Seed Yield Plot⁻¹ (Kg), Seed Yield Ha⁻¹ (Q) and Harvest Index(%)

Treatments	Test Weight (G)	Number of Pod Plant ⁻¹	Seed Yield Plant ⁻¹ (G)	Seed Yield Plot ⁻¹ (Kg)	Seed Yield Ha ⁻¹ (Q)	Harvest Index (%)
T1 CONTROL	2.70	60.15	2.82	0.44	10.55	30.00
T2 ZnSO ₄ @0.25%	2.80	67.00	2.90	0.46	11.36	31.77
T3 ZnSO ₄ @0.50%	2.91	68.33	3.03	0.49	11.92	32.55
T4 ZnSO ₄ @0.75%	3.53	74.37	3.92	0.60	13.31	34.01
T5 ZnSO ₄ @1%	3.68	75.00	4.03	0.62	14.89	35.95
T6 KNO ₃ @0.20%	2.99	70.98	3.33	0.51	12.06	32.81
T7 KNO ₃ @0.40%	3.36	72.63	3.68	0.57	13.18	33.75
T8 KNO ₃ @0.60%	3.73	75.67	4.18	0.66	15.63	37.01
T9 KNO ₃ @0.80%	3.86	78.33	4.28	0.68	16.26	38.61
SE(m)	0.21	2.78	0.27	0.044	0.97	1.22
CD	0.65	8.36	0.83	0.13	2.90	3.68

However, [10] recorded foliar feeding of zinc sulphate at 0.5% individually and in their combinations. The foliar feeding at 25 and 35 DAS showed significantly increases the seed yield plot-1. [13] Observed that the foliar application of 0.5% KNO₃ showed highest grain yield ha-1 and B:C ratio in wheat. Similar result were reported by [6], [7] that effect of potassium level on performance of chickpea and recorded maximum seed yield plant-1, seed yield ha-1 in level 90 kg potassium ha-1. Also [8] observed that the foliar application of 2% KNO₃ showed the significantly highest number of grain plant-1, harvest index and B:C ratio in wheat [18].

3.9 Harvest Index

Harvest index was significantly increased and was highest in treatment T₉ (KNO₃ 0.80%) followed by treatments T₈ (KNO₃ 0.60%), T₅ (ZnSO₄ 1.0%), T₄ (ZnSO₄ 0.75%) and T₇ (KNO₃ 0.40%) over control and rest of the treatments. But, treatments T₆ (KNO₃ 0.20%), T₃ (ZnSO₄ 0.50%) and T₂ (ZnSO₄ 0.25%) found at

par with treatment T₁ (control). This might be due to the physiological index reflecting the percentage of assimilates mobilization from vegetative organs of plant into grains.

Above results are in agreement with the experimental studies of many scientists [13]. The effect of foliar application of potassium nitrate on late sown wheat in mitigating terminal heat stress revealed that the foliar application of 0.5% KNO₃ showed highest number of grain plant⁻¹, test weight, grain yield ha⁻¹ and B:C ratio. Almost similar result were reported by [6], [7] that effect of potassium level on performance of chickpea and recorded highest harvest index in level 90 kg potassium ha⁻¹.

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
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C: Conceptualization

M: Methodology

So: Software

Va: Validation

Fo: Formal analysis

I: Investigation

R: Resources

D: Data Curation

O: Writing- Original Draft

E: Writing- Review & Editing

Vi: Visualization

Su: Supervision

P: Project administration

Fu: Funding acquisition

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Informed Consent

All participants were informed about the purpose of the study, and their voluntary consent was obtained prior to data collection.

Ethical Approval

The study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki and approved by the relevant institutional authorities.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

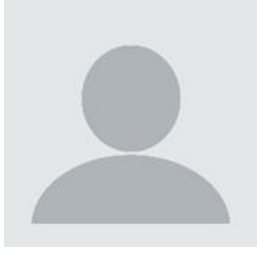
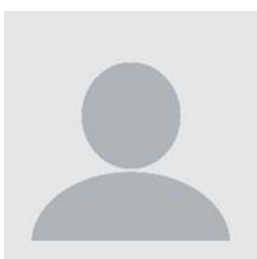
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