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RESEARCH PAPER

Influence of microclimatic variables on growth and yield of rainfed soybean under northern transition zone of Karnataka

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Abstract: A field investigation was conducted during *kharif* 2024 at the Main Agricultural Research Station, Dharwad, to assess the influence of microclimatic variables on growth and yield of rainfed soybean (*Glycine max* L. Merrill) in the Northern Transition Zone of Karnataka. The experiment was laid out in a Factorial Randomized Complete Block Design comprising three sowing windows (July 10th, August 05th, and September 09th), two plant spacings (30 × 10 cm and 45 × 10 cm) and two moisture conservation practices (with and without mulch). Results indicated that July 10th sowing significantly enhanced plant height (57.61 cm), number of leaves (9.8 plant^{-1}), leaf area index (3.0), dry matter accumulation (7.23 g plant^{-1}), seed yield (2104 kg ha^{-1}) and haulm yield (2475 kg ha^{-1}), followed by August 05th (1381 and 2103 kg ha^{-1}, respectively), while September 09th sowing produced the lowest yields (1042 and 1252 kg ha^{-1}, respectively). 30 × 10 cm increased growth and productivity, with seed yield of 1619 kg ha^{-1} compared to 1399 kg ha^{-1} at 45 × 10 cm. Mulching further improved performance, recording higher seed (1603 kg ha^{-1}) and haulm yields (2004 kg ha^{-1}) relative to non-mulched plots (1415 and 1883 kg ha^{-1}, respectively). The study demonstrated that timely sowing on July 10th, at 30 x 10 cm spacing and mulching, optimizes microclimatic conditions for soybean, leading to significantly higher growth, biomass accumulation, and yield under rainfed conditions.

Key words: Mulching, Sowing window, Spacing

Introduction

Soybean, (*Glycine max* L. Merrill) is one of the most important legume oilseed crops, valued for its high protein content and versatile uses in food, feed and industrial applications. Globally, Soybean contributes significantly to oilseed production, with India being one of the major producers. In Karnataka, soybean has gained prominence as a *kharif* season crop under rainfed conditions, particularly in the Northern Transition Zone, where it plays a crucial role in sustaining farm incomes and improving soil fertility through biological nitrogen fixation.

The meteorological parameters play an important role in deciding the success or failure of the crop as these strongly influence the physiological expression and genetic potential of the crop. It is well known that yield from any given crop or variety depends on the availability of certain optimum conditions of solar radiation, temperature, relative humidity, surface air and soil temperature, heat units *etc*. during different stages of soybean crop growth.

Sowing date is the variable with the largest effect on crop yield (Calvino *et al.,* 2003a and b). Planting date is an important factor affecting soybean growth, development and yield (Zhang *et al.,* 2023), and grain quality (Rahman *et al.,* 2005).The grain yields are generally greater from earlier planted soybean due to longer duration of vegetative and reproductive stages (Chen and Wiatrak, 2010). Delayed planting date and unfavorable environmental conditions have a negative effect on soybean growth, development and yield. Delayed sowing generally shifts reproductive growth into less favorable conditions with shorter days, lower radiation and temperatures (Egli and Bruening, 2002).

In view of the above considerations the present investigation entitled "Influence of microclimatic variables on phenology of rainfed Soybean in Northern transition Zone of Karnataka" was carried out during *kharif* 2024 at Main Agricultural Research Station, UAS, Dharwad with the following objectives:

To study the effect of microclimatic conditions on growth and yield of Soybean.

Material and methods

The field experiment was conducted during *kharif* 2024 at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, located in the Northern Transition Zone of Karnataka. The experiment was laid out in a Factorial Randomized Complete Block Design (FRCBD) with three replications and twelve treatment combinations. The treatments consisted of three windows (July 10, August 05 and September 09), two plant spacings (30 × 10 cm and 45 × 10 cm), and two moisture conservation practices (with mulch and without mulch).The soybean variety DSb-34 was used for the study. Standard agronomic practices recommended for the region were followed to raise the crop.Observations recorded are as follows, the plant height was measured from the ground level to the tip of the main shoot in five randomly selected plants per net plot at harvest. The average height was worked out and expressed in centimeters (cm).Number of leaves per plant: At harvest, the number of trifoliate leaves per plant was recorded from five randomly selected plants. The mean value was calculated and expressed as the number of trifoliate leaves per plant. Dry matter accumulation per plant and it's partitioning: Five plants were uprooted randomly from each treatment. The root portion of the plant was discarded and remaining portion of leaves, stem and reproductive parts were separated and kept in hot air oven and dried at 70ºC till constant weight was obtained. The data obtained was used to estimate the total dry matter production per plant. Leaf area index was calculated by dividing the total leaf area (leaf area per plant × number of plants per meter row length) by the ground area occupied by those plants. Observations were recorded 75 DAS.

$$\text{LAI} = \frac{\text{Leaf area per plant (dm}^2\text{)}}{\text{Land area occupied by the pant (dm}^2\text{)}}$$

Grain yield (kg ha^{-1}): Pods harvested from the net plot were threshed, seeds cleaned and the yield per hectare was computed and expressed in kg ha^{-1}. Haulm yield (kg ha^{-1}): The net plot biological yield was weighed before threshing. Haulm yield was calculated by subtracting seed yield from the total biological yield and expressed in kg ha^{-1}.

Results and discussion

The growth parameters of soybean were markedly influenced by sowing window, plant spacing and mulching practices (Table 1). Among the sowing window, crop sown on July 10th exhibited significantly greater plant height (57.61 cm), number of leaves (9.8), leaf area index (3.0) and dry matter production (7.23 g plant^{-1}), followed by August 05th sowing having plant height (52.07 cm), number of leaves (8.5), leaf area index (2.5) and dry matter production (6.12 g plant^{-1}) and September 09th sowing having plant height (45.01 cm), number of leaves (7.5), leaf area index (2.1) and dry matter production (4.90 g plant^{-1}), respectively.

The superior performance under July 10th sowing is attributed to favorable temperature, radiation and moisture availability during the vegetative phase, which supported vigorous growth and resource capture. In contrast, August 05th and September 09th sowing shortened the vegetative period and exposed the crop to suboptimal conditions, thereby restricting canopy development and biomass accumulation. Similar trends have been reported earlier, where timely sowing ensured better synchronization of crop phenology with favorable microclimatic conditions (Calvino *et al*., 2003; Egli and Bruening, 2002). Plant spacing also exerted a significant effect, with closer spacing (30 × 10 cm) promoting higher growth attributes than wider spacing (45 × 10 cm). Sowing at 30 x 10 cm spacing recorded significantly higher plant height (52.33 cm), number of leaves (8.8), leaf area index (2.7) and dry matter production (6.37 g plant^{-1}) compared to sowing at 45 x 10 cm spacing plant height (50.79 cm), number of leaves (8.4), leaf area index (2.3) and dry matter production (5.79 g plant^{-1}). This is due to a greater plant population per unit area, which enhanced light interception and overall canopy efficiency.

Among moisture management practices, significantly higher plant height (52.78 cm), number of leaves (8.7), leaf area index (2.7) and dry matter production (6.20 g plant^{-1}) was recorded with mulching compared to without mulch having plant height (50.35 cm), number of leaves (8.5), leaf area index (2.4) and dry matter production (5.97 g plant^{-1}).

Mulching consistently improved growth performance over the non-mulched plots by conserving soil moisture and moderating soil surface temperature, thereby facilitating better physiological activity. These results are consistent with earlier findings that emphasize the importance of early sowing and soil moisture management for sustaining soybean growth under rainfed conditions (Chen and Wiatrak, 2010; Zhang *et al*., 2023).

The yield-attributing traits followed a similar trend, with the July 10thsowing producing the highest seed yield (2104 kg ha^{-1}) and haulm yield (2475 kg ha^{-1}), while the September 09thsowing

Table 1.Growth and yield parameters of Soybean as influenced by sowing window, spacing and moisture management practices

Treatments	Plant height (cm)	Number of leaves per plant	Leaf Area Index	Dry matter production (g/plant)	Seed yield (kg ha^{-1})	Halum yield (kg ha^{-1})
Sowing window						
D_1: July 10	57.61	9.8	3.0	7.23	2104	2475
D_2: August 05	52.07	8.5	2.5	6.12	1381	2103
D_3: September09	45.01	7.5	2.1	4.90	1042	1252
S.Em±	0.13	0.02	0.02	0.02	16.6	14.0
C.D.(P=0.05)	0.37	0.09	0.05	0.05	48.8	41.2
Spacing						
S_1=30cm×10cm	52.33	8.8	2.7	6.37	1619	2025
S_2=45cm×10cm	50.79	8.4	2.3	5.79	1399	1861
S.Em±	0.08	0.01	0.01	0.01	11.1	9.4
C.D.(P=0.05)	0.24	0.06	0.03	0.03	32.5	27.5
Mulching						
M_1= With mulch	52.78	8.7	2.7	6.20	1603	2004
M_2= Without mulch	50.35	8.5	2.4	5.97	1415	1883
S.Em±	0.08	0.01	0.01	0.01	11.1	9.4
C.D.(P=0.05)	0.24	0.06	0.03	0.03	32.5	27.5

recorded the lowest yields (1042 and 1252 kg ha^{-1}, respectively). The enhanced productivity in July 10thsowing isdue to the longer duration available for vegetative and reproductive growth, which allowed for greater assimilate production and partitioning towards seed development. These findings align with reports that earlier sowing enhances pod formation and seed filling, ultimately resulting in higher yields (Rahman *et al*., 2005; Zhang *et al*., 2023). Plant spacing and mulching also significantly influenced yield. Closer spacing (30 × 10 cm) recorded higher seed (1619 kg ha^{-1}) and haulm yields (2025 kg ha^{-1}) compared to wider spacing seed (1399 kg ha^{-1}) and haulm yields (1861 kg ha^{-1}), due to improved canopy closure and higher plant population. Similarly, mulching (1603 and 2004 kg ha^{-1} for seed and haulm yield, respectively) enhanced productivity relative to no mulch (1451 and 1883 kg ha^{-1} for seed and haulm yield, respectively), as a result of improved moisture retention and favorable microclimate for pod setting and grain filling. These results corroborate earlier studies highlighting the role of timely sowing, optimum plant density and soil conservation practices in maximizing soybean productivity under rainfed ecosystems (Egli and Bruening, 2002; Chen and Wiatrak, 2010).

Conclusion

The study clearly demonstrated that soybean growth and yield were significantly affected by sowing window, spacing and mulching practices in the Northern Transition Zone of Karnataka. Early sowing on July 10th, combined with closer spacing (30 × 10 cm) and mulching, proved to be the most effective management practice, ensuring higher plant growth, greater dry matter accumulation and superior seed and haulm yields under rainfed conditions. Hence, timely sowing (July 10th) supported by moisture-conserving practices should be emphasized as a strategy for enhancing soybean productivity and resilience in rainfed farming systems**.**

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